SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1910.

GENERAL PHYSICS.

1665. *Gravity Rollers for Suspending Maps, &c.* **R. W. Weekes.** (Engineering, 90. pp. 547–548, Oct. 14, 1910. Paper read before the British Assoc. at Sheffield.)—Describes a gravity system of suspending maps, theatre curtains, &c., which has certain advantages over springs for rolling up the maps when not in use. The roller carrying the curtain or map is suspended by means of a cord C which passes round a pin B at the end of the roller. The roller A is at the lower end of this cord when the map is fully wound up. There is a cross-bar or weight W at the lower end of the map. When this is pulled down the map commences to unroll, and the roller A rises, the supporting cord winding up round the projecting pin B. There are two turning moments exerted on the roller: the first of these is due to the combined weights of the roller A and the map and of the bottom weight W; the product of these weights into the radius of the pin B, plus one-half the thickness of the cord, gives the torque which tends to roll the map up. In the other direction the couple tending to unwind the map is due to the weight W and the weight of that length of the map which is unwound. The sum of these two weights acts at the radius of the roller plus the thickness of the map still wrapped on the roller. By suitably proportioning the diameters of the roller and the pin, and the weights of the roller, map, and bottom bar it can be arranged so that the map is practically in equilibrium in any position. In those cases where absolute balance is not easily obtainable, the map can be made to stand in any position by means of any device which alters the perfect concentricity of the roller and the pin. The advantages of this system of suspension may be briefly stated thus: (1) The maps can be hung up on the cords from the ground-level, and any map required can be easily attached to the same cords. (2) The act of unrolling the map automatically raises it to the desired position. (3) The map can be rolled up when done with, and thus kept clean. (4) The gravity control avoids the use of springs, and is cheaper. Diagrams are given of the arrangement, which is in the hands of Philip and Sons. A. W.

1666. *Hardness-testing by the "Falling Ball" Test.* **J. J. Schneider.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 1681–1687, Sept. 24, 1910. Extract.) —The method employed in these tests is to allow a hardened steel ball to fall on the surface of the material and to measure the height to which the ball returns and also the diam. of the depression made in the material tested. The apparatus consists of a tripod stand provided with levelling screws and having a flat surface on which the specimen is placed and accurately levelled. An upright pillar fixed in the base carries the arrangement for releasing the ball, the height of this carrier being adjustable. For releasing the ball an ordinary photographic iris-diaphragm with pneumatic release is employed. The ball is placed on the diaphragm and can be released by pressing a valve which opens the diaphragm. The ball falls down in front of a glass scale provided with a movable lens which is located near the point to which the ball is expected to rise. With practice this rise can be read to 1 mm. To catch the ball on its rebound, so that it will not strike the test-piece twice, a second iris diaphragm is provided which is placed immediately above the test-piece. As soon as the ball has passed upwards on the return the diaphragm is closed by pressing a pneumatic valve similar to the releasing apparatus. The apparatus allowed a max. fall of 400 mm. with a ball 4 to 6 mm. diam. The article records numerous experiments to determine the relation between material and indentation areas for the softer materials and to institute comparison between these results and the static results as obtained in Brinell's hardness test. In the case of the harder materials relations are established between hardness and height of rebound with different-sized balls. Curves are given for the relation between indentation area and height of fall. As a whole the results, which are very regular and consistent, seem to indicate that this method has much to recommend it for simplicity, and the standard results recorded may well form a basis for future experiments using the same or similar apparatus.

C. A. M. S.

1667. *Simple Method to determine Change of Shape of a Bent Rod-shaped Body.* **R. Baumann.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 1675–1682, Oct. 1, 1910.)—The method discussed is applicable to such cases as a circular or elliptical ring loaded at one or more points, or to tubes of varying section such as a Fox or Morison furnace tube, &c., loaded by axial compression. The author first establishes the formula—

$$\Delta y_c = \frac{\alpha}{\theta} Q \int_0^{\phi_c} a^2 r \, d\phi,$$

where Δy_c is the displacement of the point of application of a load Q, α is the tensile coefficient of elasticity (= 1/E), θ the moment of inertia at any point D, a the shortest distance between D and the point of application of the load (C), r is the radius of curvature at the point D and ϕ, ϕ_c the angles made between the normal to the point D and the point C respectively with the x-axis. To obtain a solution of the integral a method is described by which a and then a^2r can be plotted, from which curve the integral is found by measuring the area with a planimeter. Multiplying by $\alpha Q/\theta$ solves the equation. The distortion of the tangent at C is deduced in a like manner from a graphical solution of—

$$\phi = \frac{\alpha Q}{\theta} \int_0^{\phi_c} a r \, d\phi.$$

The mean height of the graph of *a* gives a means of determining the bending moments, and statically indeterminate problems (such as a closed ring) can by this means be reduced so as to give the bending moment at any section. A method is explained for extending the process to straight tubes of varying section acting as struts. A Fox tube is taken as an example of the latter case, and is worked out in some detail, approximate formulæ being deduced.

C. A. M. S.

1668. *Hardness and its Measurement.* **G. A. Roush.** (Metallurgical and Chem. Engin. 8. pp. 578–581, Oct., 1910.)—The author analyses the results of the hardness and other mechanical tests on the alloys of nickel copper and monel metal with electrolytic iron [see Abstracts Nos. 446, 616, 1777, 1781 (1910)], with a view to determining whether any relationship exists between hardness and density, elasticity, ductility and tenacity, all of which affect the results in a degree depending upon the method of testing. It appears that the scleroscope gives results only approximately proportional to the elastic limit, and that the simple linear relationship claimed by Shore does not exist. An examination of the elongation and reduction-of-area curves points to the fact that the difference between the hardness and elasticity curves is caused by the ductility of the material, which at the same time influences the difference between the elastic and ultimate stresses. An attempt has therefore been made to reproduce the ultimate stress curves from the hardness curve, the conversion factor being obtained by dividing the ultimate stress by the corresponding hardness in the middle of the curve for each series of alloys. This factor, which varies from 2·02 in the case of annealed copper to 2·60 in the case of annealed nickel alloys, was then used to convert the hardnesses into ultimate strengths, the curves obtained agreeing very closely with the original curves. There appears to be a relation existing between hardness and ultimate stress, but it is of a somewhat complicated nature.

F. C. A. H. L.

1669. *Viscous Flow in Metals.* **E. N. da C. Andrade.** (Roy. Soc., Proc. Ser. A. 84. pp. 1–12, June 9, 1910. Phys. Zeitschr. 11. pp. 709–715, Aug. 15, 1910.)—The flow of a lead wire loaded beyond its elastic limit becomes viscous after a time, *i.e.*, the extension is proportional to the time, and the author has investigated the variation of the rate of flow with the load. The increase of length and diminution of sectional area of the wire having produced disturbing factors in the earlier experiments, the difficulty was obviated by the use of a "hyperbolic weight" sinking into a liquid, the form of the weight being so designed that the upthrust at any moment varied inversely as the length, and directly as the sectional area of the wire, thus maintaining constant stress. Experiments were carried out on pure lead (99·8 per cent.), fuse wire (Sn 21·5, Pb 78·5 per cent.), and pure copper, the results showing that all these metals are subject to viscous flow right up to their breaking-points. Extension is divided into three parts: (1) immediate extension on loading, (2) an initial flow which gradually disappears—termed the β flow, and (3) the viscous flow—a constant flow throughout the extension. In copper the immediate extension is large and the viscous flow small in comparison with lead, a peculiarity being the appearance of sudden slips at irregular intervals. The formula $l = l_0(1 + \beta t^{1/3})e^{kt}$, where β is a measure of the β-flow and k a measure of the viscous flow, represents the extension-time curves very closely. For very large values of the stress β tends to become constant. The "fluidity" (k/stress) stress curve is roughly hyperbolic with one asymptote parallel to, and the other steeply inclined to the stress axis.

F. C. A. H. L.

1670. *Relation between the Resistance to Crushing of Cylindrical Bodies and their Dimensions.* **F. Robin.** (Comptes Rendus, 151. pp. 639–641, Oct. 10, 1910.)—The resistance to crushing of a metal is defined by means of a right circular cylinder of the material which is subjected to a single axial hammer blow of such magnitude that the height is reduced by one-fifth. The "crushing resistance number" under these circumstances is obtained by dividing the energy expended in kg.-m. by the total volume of the metal in cm.^{3}. The numbers, at 20° C., for various metals are given; several grades of steel are mentioned, the resistances varying from 14 for steel with 0·05 per cent. carbon to 58 for steel with 0·7 C, 11 Ti, 4·5 Cr. The values for Ni, Al, and Cu are 16, 4, and 6 respectively. Tresca's Law states that: "The crushing resistance, defined by the number of kg.-m. expended per cm.^{3} of material deformed by a shock of given speed and producing a given deformation, is constant for homogeneous solids." The author then gives some average results of tests on steels at white and red heat, to determine a relation between the resistance to crushing under a blow defined as above and the dimensions of the cylinder. For cylinders of constant base, the resistance was found to decrease slowly as the height increased, the change approximating to a rectangular hyperbola law. For constant height the resistance varies directly as the area of base. Combining the two, the general law of resistance to crushing of cylinders of the dimensions tested is expressed approximately by a hyperbolic paraboloid. C. A. M. S.

1671. *Experiments with Centrally and Eccentrically Loaded Pillars of Brickwork and Cement.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 1625–1631, Sept. 24, 1910.)—The article describes tests on brick columns of the approximate dimensions 80 × 80 cm. in plan and 155 cm. in height. Two kinds of bond were employed: one a special column bond composed of 70 whole bricks, 140 three-quarter bricks, and 10 half bricks (headers); the other ordinary English bond, employing 180 whole bricks. The mortar used consisted of 1 part Portland cement to 4 parts of sand. Tests were also made on cement columns, 77 cm. × 88 cm. in plan and 150 cm. in height, composed of 1 part Portland cement, 2½ parts Rhine sand, 3 parts river gravel, and 4 parts broken limestone. The cement with 3 parts of standard sand had a tensile strength of 34 kg./cm.^{2} after 28 days, and a compressive strength of 310 kg./cm.^{2}. The machine used had a capacity of 500,000 kg., the forces being applied through ball joints. Compression heads of heavy cast-iron were employed at both ends of the columns, and specially accurate means used to determine the eccentricity. Seven columns employing the bond given first above were tested, two with central load, one with 4 cm. eccentricity, two with 8 cm., and two with 12 cm. eccentricity. Full details of the tests, including the tabulated loads at first sign of cracking are given in the article together with the calculations to determine the peripheral stresses in the column. In direct compression the average breaking load for the brick columns was 102·5 kg./cm.^{2}. The maximum was reached with 8 cm. eccentricity when the average calculated max. compressive stress on one face was 154 kg./cm.^{2} and max. tension 15 kg./cm.^{2} in the opposite face. [These calculations assume Hooke's Law.] Tests with the second set of columns gave very similar results. The cement column with central load was not broken when the full capacity of the machine was reached which gave a compressive stress of 169 kg./cm.^{2}. With 8 cm. eccentricity the stresses were 211 kg./cm.^{2} compressive stress and 25 kg./cm.^{2} tensile stress in the opposite face. With 12 cm. eccentricity the respective stresses were 174 and 54 kg./cm.^{2}. Experiments were also made on separate bricks and small cubes of cement and comparisons are given between the tests on the large and small specimens. The article is illustrated with reproductions of photographs of the columns after test and with curves showing the load at first sign of cracking and of final fracture, plotted as a function of the eccentricity of loading. C. A. M. S.

1672. *Theory of the Gyroscope and its Technical Applications.* **A. Fuchs** and **R. Katzmayr.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 1522–1529, Sept. 10, and pp. 1574–1579, Sept. 17, 1910.)—These articles commence with a theory of the behaviour of a rotating and precessing body of revolution. From the changes introduced by the precession, velocities, perpendicular to the plane of the rotating ring are found, then the corresponding accelerations and forces, and finally the moment of the latter about the third rectangular axis is calculated. But this is of only *half* the value of the torque needed to maintain the steady precession in question. The other half is then derived from curvatures of the paths of the particles forming the rotating and precessing ring. Precession with nutation and also the spinning of a top upon a blunt spike are then treated, thus concluding the theoretical portion. The technical part is a well-illustrated account of Schlick's ship-steadying gyroscope, Brennan's mono-rail car, the rifle projectile, torpedoes, and the gyroscope compass. E. H. B.

1673. *Hydraulics: Transformation of Water Velocity to Pressure.* **K. Andres.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 1585–1590, Sept. 17, and pp. 1637–1641, Sept. 24, 1910.)—A paper dealing with the transposition from water velocity to pressure. A research is described made with the object of determining the section of the tube giving the best results, *i.e.*, with the least energy loss. Water was driven into an air chamber 2 m. high and 1 m. diam. by a differential pump driven by a motor, the speed of which could be adjusted to give any delivery from 1·5 to 7·9 litres per sec. About 4/5ths of the air chamber was occupied by air at a pressure of from 6 to 11 atmos., thus securing a uniform delivery from the outlet valve. In all 22 tubes, some of cylindrical, others of square section, were experimented on, the pressure at different points along the tubes being measured by means of a Stodola tube, 2·5 mm. outside diam., placed along the axis of the tube under test. The velocity in the narrowest part of the tubes varied from 10 to 40 m. per sec. Sections are given of all the tubes used. As a result of the research the following conclusions are drawn: In order to transform water velocity to pressure, the water flowing with the velocity $v_{\text{max.}}$ must pass through a widening tube, in which the velocity gradually decreases to a minimum value $v_{\text{min.}}$. The hydraulic pressure increases then within the tube by the amount $\eta(v^2_{\text{max.}} - v^2_{\text{min.}})/2g$. The efficiency η is, within the limits of the experiment (10 to 40 m. per sec.), independent of the max. velocity; it increases with increased eddying in the water, and in other respects is determined by the shape of the tube. It is greater for tubes of circular section than for corresponding ones of square section. Cone-shaped tubes prove to be better than those having linear or parabolic pressure-increase. The losses are due to friction and to solution of air. The first of these depends on the roughness of the walls of the tube; the second depends only on the angle the walls of the tube make with the axis. For conical tubes a diagram is given from which both values can be determined beforehand. The results apply only to those cases in which, close to where the velocity is greatest, the hydraulic pressure has a positive value. A. W.

1674. *Flow of Gas through Small Pipes.* **C. Carpenter.** (Eng. Record, 62. p. 884, Oct. 1, 1910.)—Recent experiments made by D. Chandler, of the Metropolitan Gas Co. (New York), acting under the direction of the author, indicate, in the latter's opinion, that certain formulæ for the flow of gas in pipes give inaccurate results, especially with reference to smaller pipes. Tests carried out by various experimenters have indicated that the constant in Pole's formula is too large; the tests made for the author have confirmed this, especially with reference to small pipes. Experiments were made to ascertain, if possible, the principles affecting the flow of gas through small pipes and services. The results obtained for varying lengths of ¼-in., ⅜-in., and ½-in. composition pipe show that (1) the constant in Pole's formula is much too large, as before stated; (2) for small differences of pressure the law that the volume discharged varies as the square of the pressure is not operative; the volume apparently, within certain limits, varies directly as the pressure; (3) the law that the volume discharged varies inversely as the square of the length does not apply with small differences of pressure and all lengths of service. Osborne Reynolds has shown that there exists a certain relationship between velocity and diam. of any size pipe for any given fluid, which causes that velocity to be critical. The author believes there may be several points in the scale where a certain velocity becomes critical, requiring a change of law at each particular point. He considers viscosity has a great deal to do with the phenomena observed, and that the effect of viscosity is greater in pipes of large sectional area than in small services, since with the latter the skin area exposed is greater per unit of gas. Therefore the velocity in small pipes has to be greater than in large mains for the same pressure-volume law to be operative. A. W.

1675. *Attraction Constant of Molecule of Compound.* **R. D. Kleeman.** (Chem. News, 102. p. 167, Sept. 30, 1910. Abstract of paper read before the British Assoc. at Sheffield.)—The author has previously deduced from surface tension and latent heat data that the attraction between two molecules of the same kind is $K/(\Sigma\sqrt{m_1})^2z^5$, where z is the distance between them, m_1, &c. are the masses of the constituent atoms, and K is a quantity having the same value for all substances at corresponding temperatures, but must contain an undetermined function, as it is shown in the paper that the law of attraction cannot be completely determined from the above data. He calls $\Sigma\sqrt{m_1}$ the attraction constant, and finds that, where T_c is the critical temperature, the properties of the quantity $T_c/\Sigma\sqrt{m_1}$ run parallel with the purely chemical properties in the ethers, esters, nitriles, amines, primary alcohols, and unpolymerised secondary alcohols. The study of this quantity should therefore be of use in classifying chemical compounds into groups, and does, *e.g.*, divide the amines into the primary, secondary, and tertiary amines. [The subject is treated at greater length in Phil. Mag. 20. pp. 905–920, Dec. 1910.] G. W. de T.

1676. *Origin and Growth of Ripple Mark.* **Mrs. H. Ayrton.** (Roy. Soc., Proc. Ser. A. 84. pp. 285–310, Oct. 21, 1910.)—By observation and experiment it is concluded that there are three ways in which sand ripples are originated, viz., the "uneven surface" method, the "differential motion" method, and the "brush" method. The first could, unaided, give rise to irregular ripple-mark only, since it consists in piling up sand in places where the surface chances to be uneven. The second is the method by which single ridges arise at the loops of stationary waves. The third is that by which the brush of the vortex in the lee of any existing dune or obstacle sweeps up a new ridge beside it, leaving a hollow along the neutral line of the vortex. The last two methods are evidently capable, unaided, of originating and then extending *regular* ripple-mark wherever water is oscillating over sand, whether its surface be smooth or uneven to start with. These last two, therefore, are clearly the *essential* methods, while accidental unevennesses of surface merely delay uniformity in the results. Some of the experiments here described and others to be published later lead to the conclusion that although the water is disturbed in the lee of an obstacle over which there is a *steady flow*, yet *no definite vortex* in the least resembling a *ripple vortex* forms there. Hence a *steady* current is *unable either to generate or to maintain ripple-mark*. The paper has 15 illustrations, including photographs of experimental arrangements and the results thereby obtained. E. H. B.

1677. *Shape of the Molecule.* **R. D. Kleeman.** (Phil. Mag. 20. pp. 445–450, Sept., 1910.)—On the basis of results obtained in former papers [see Abstract No. 1200 (1910)], the author arrives at the conclusion that the molecule cannot be spherical, but that its shape may be approximately represented by an oblate spheroid having its axes in the ratio $(\Sigma m^{\frac{1}{3}})^{\frac{3}{2}}/\Sigma m^{\frac{1}{2}}$, where m is the mass of an atom. It is shown that the variation with temperature of the coefficients of viscosity and diffusion afford no information as to the effect of temperature on the shape of the molecule, but the expression for the attraction already given [*loc. cit.*] suggests that the variation of K with the temperature is due, not to variation in the attraction, but to change in configuration, giving rise to variation in the law of force. G. W. DE T.

1678. *Determination of Molecular Diameter from Kathode-ray Absorption.* **J. Robinson.** (Univ. of Durham Phil. Soc., Proc. 3. 4. pp. 195–199, 1909–1910.)—Experiments with the gases H, O, N, CO, A, CO_2 and He led to the conclusions that Lenard's mass law holds only for large ray-velocities. As the velocity diminishes the absorption increases, slowly at first, and reaches a maximum for a small value of the velocity. The increase of absorption requires an abnormally small velocity in the case of helium and hydrogen, and in the latter case the absorption attains a large limiting value. The max. absorption values were used to determine the total cross-sections of the molecules in 1 cm.^{3} of gas, and from this the diam. of a molecule was calculated by means of Planck's expression for the number of molecules in a gm.-molecule. G. W. DE T.

1679. *Change of Wind with Altitude.* **A. J. Henry.** (Mount Weather Observatory, Bull. 2. 6. pp. 357–374, 1910. Paper read before the Amer. Assoc. for Advancement of Science, Dec., 1909.)—The paper discusses the observations made at Mount Weather. No less than 39 per cent. of the surface winds are from NW., and 20 per cent. are from SE. The remaining 41 per cent. are distributed fairly uniformly over the other directions. This peculiar distribution of wind is not shared by low-level stations in the neighbourhood. Kite ascents, of which we have a total of 686 made during the years 1908, 1909, show that winds from easterly directions are very rare at altitudes of 1000 m. or more. Out of 147 occasions of surface winds from between NE. and SE. only 58 showed winds from within the same limits up aloft. The prevailing directions in the upper air are between NW. and SW. The small vertical thickness of easterly winds is thus even more striking at Mount Weather than it is in Europe. The remainder of the paper discusses the amount of change of wind with altitude. In 54 per cent. of the cases the change at 1000 m. is in a clockwise direction, in 26 per cent. it is counter-clockwise. The most conspicuous cases of clockwise change occurred with a "high" area to the E. of Mount Weather and a "low" advancing from the W. In such circumstances we have SE. surface winds and W. or SW. winds at 1000 m. Counter-clockwise changes occur with high pressure to the W. and low pressure to E. or N. On two occasions of "high" to the W. of Mount Weather primary "laws" were shown in the NE., with "secondaries" directly E. of the station. With this pressure distribution we find surface winds from NW. circulating round the "secondary" with upper currents from SW. flowing towards the primary "low." R. G. K. L.

1680. *Motion of Particle about Doublet.* **J. H. Jeans.** (Phil. Mag. 20. pp. 380–382, Aug., 1910.)—The author has come to different conclusions from those of J. J. Thomson [see Abstract No. 1286 (1910)]. He finds that the equation of motion of this particular problem can be completely integrated, apparently the only case in particle dynamics of a solution being obtainable where the orbit is not confined to a plane. The final energy integral is obtained in the form $r^2 = C/E + 2Et^2$, where C is a constant of integration. When E is negative the particle ultimately falls into the doublet. For $E = 0$ the orbit is spherical. For E positive the orbits are also unstable, r becoming either zero or infinite. These results appear to be subversive of the physical theory suggested by J. J. Thomson. G. W. DE T.

1681. *The June "Cold Spell" in Italy.* **F. Eredia.** (Accad. Lincei, Atti, 19. pp. 321–326, Oct. 2, 1910.)—The "cold spell" of June has been noticed by various writers in different countries, and for Italy Ragona gives the dates May 30–June 12 for its duration. De Giorgi prefers June 1–18, and Eredia for Catania gives June 4–14. Rijckevorsel (Phil. Mag., p. 459, 1898), has noticed the generality of this phenomenon throughout Europe and Lancaster in 1903. Luizet, Moreaux, and Gheorghin, by examining past records of temperature in France and Roumania, have shown that this lowering of temperature is a periodic phenomenon in those countries also. Marten, by the examination of temperature observations in 101 towns of Central Europe for the period 1884–1898, has arrived at similar results, but found that the temporary fall of temperature is less pronounced in the higher latitudes. The present note contains the result of investigations for Italy. The author has obtained observations from 120 stations in that country, most of these being for a period of 40 years (1866–1906). For each of these stations the mean temperatures for each decade (10-day period) of May, June, and July are taken and compared with those of the following decade, and tables of these differences are given. From these figures it is clearly seen that throughout Italy there is a regular fall of temperature in the second decade of June, and since this is manifest so clearly in the mean values we must conclude that it represents a regular periodic diminution characteristic of the yearly march of temperature. For Venetia and Lombardy, as also in the central parts of Middle Italy, the change of temperature is more considerable than for the rest of the country, and a figure is given showing, by differences of shading, the local variations. From examination of Hann's map of the mean barometric pressure over Europe in June we find a region of low pressure over Russia and one of higher pressure in Spain, and thus N. and NW. winds prevail throughout Central Europe, whilst in the Mediterranean district the winds will be mainly W. and SW. Thus to account for this regular fall of temperature during the second decade of June we must suppose that the winds coming from the cold regions bring about this effect, and the more markedly the colder these regions are. This effect is also aided by the orography of the localities affected. Thus the smaller fall of temperature in Piedmont and Lombardy as compared with Venetia must be attributed to the influence of the obstacles presented to the air-currents by the Alpine heights, and the similar case of the maritime regions as compared with the interior of Central Italy is due to the action of the sea, which tends to moderate temperature changes. In certain years, however, the distribution of barometric pressure tends to accentuate this action, in others to diminish it. We may, in conclusion, consider that the fall of temperature in the second decade of June constitutes a true climatological feature of the Italian stations, more especially marked in the northern ones. F. W. H.

1682. *Observation of the Superior Bi-tangent Arc of the Halo of* 46°. **L. Besson.** (Comptes Rendus, 151. pp. 693–695, Oct. 17, 1910.)—Bravais predicted the existence of tangent arcs which he named supralateral arcs of the halo of 46°, but hitherto they have never been observed with certainty. On Sept. 26, 1910, however, a phenomenon was witnessed at Montsouris which manifested the characteristics of the arc in question. At first sight it might have been mistaken for the large halo, from which it was distinguished, however, by its very weak curvature, and by the fact that it was not tangential to the circumzenithal arc, which it met at a fairly large angle. The colouring was very vivid. The sun's altitude was 21° 45′. By Bravais' theory the arc in question is due to ice crystals with horizontal axes. It may therefore be noted that the superior tangent arc of the halo of 22°, and the right infralateral arc of the halo of 46°, which are also due to horizontal ice prisms, were visible, and that the former was extraordinarily distinct and prolonged. The halo of 22° was faint and incomplete, and therefore the halo of 46°, which is generally fainter than the halo of 22°, was not likely to be visible. Fragments of the parhelic circle and the right paranthelia of 120° were observed and measured on the same occasion. A. E.

1683. *Origin of Cometary Bodies and Saturn's Rings.* **H. Wilde.** (Manchester Lit. and Phil. Soc., Mem. 55. 1. pp. 1–20, 1909–1910.)—The first part of the paper is a further exposition of the author's theory of the origin of comets and cometary bodies from the interior of the planets of the solar system [see Abstract No. 801 (1910)], with new illustrations drawn from experimental mechanics, by which the direct and retrograde motions of cometary bodies are more fully explained. The author considers that the recently discovered satellites of Jupiter and Saturn, which have retrograde motions, are planetary ejectamenta, and from their comparative minuteness are hardly entitled to rank as satellites. The theory advanced by Olbers, that the planetoids are fragments of an exploded planet, finds confirmation in the great irregularities of their orbits, and the direct and retrograde motions of cometary bodies. The author next discusses the origin of Saturn's rings. He is of opinion that the rings are the ejectamenta of Saturn when its diminishing energies were insufficient to eject a comet with its train of meteorites, or a cometary satellite. Evidence is adduced to show that the interior rings were formed some time subsequently to the outermost one, which is separated from the others by an annular space of 2585 miles. The opinions of Kant on the origin of the Zodiacal light are referred to, who considered it to be an efflux from the surface of the sun. Herschel and others have since regarded it as an accretion of cometary matter from outer space. The author considers that this singular object is an ejection from the interior of the sun of light elementary substances in a state of extreme subdivision and extending some distance beyond the earth's orbit. A. P. H.

1684. *Improbability of Random Distribution of Stars in Space.* **K. Pearson.** (Roy. Soc., Proc. Ser. A. 84. pp. 47–70, June 9, 1910.)—The author discusses the series of stellar parallaxes published by Newcomb and the Yale observers, and analyses the results by his correlation method, assuming at first certain distributions of the stellar system. It is found that, as more stars are taken into consideration, the less probability is there for supposing a uniform distribution through space. If a random distribution does exist, it follows that there must be a correlation between distance and intrinsic brilliancy. **F. W. Dyson.** (Ibid. pp. 369–371, Oct. 21, 1910.)—The author shows that the conclusion of Pearson as to the selective distribution of the Newcomb and Yale stars could be obtained by a simple examination of the "probability" values of the intermediate parallax values. The formulæ giving the numbers of stars of a stated mean magnitude are also derived simply, the resulting values agreeing with those given by Pearson. Owing to the possibility of non-physically related stars being included in catalogues of double stars, the discussion of such lists for evidence of stellar distribution is not recommended. C. P. B.

1685. *Oblique Belt on Jupiter.* **S. Bolton.** (Nature, 84. pp. 362–363, Sept. 22, 1910.)—The dark belts on Jupiter are usually parallel to the planet's equator, but at times an abnormal formation has been recorded, notably in the Northern Hemisphere in 1860. A similar occurrence was observed in April and May, 1910. The newly formed oblique belt stretched across the white zone between the S. temperate and SS. temperate belts. At no point, however, did it coalesce with these belts. Evidence is given from the drift of various spots that the phenomenon appears to be due to the interaction of two surface currents of different velocities, and sketches are given illustrating the appearance on April 1, April 6, and May 2, 1910.

C. P. B.

REFERENCES.

1686. *Comparisons of Astronomical Time by Electric Signals.* **R. Bourgeois.** (Comptes Rendus, 151. pp. 583–587, Sept. 26, 1910.)—Description of the connections at each station for the electric transmission of electric clock signals for determining the difference of longitude between two places a long distance apart and only connected by cable. The two stations being used at present are Brest and Dakar, 4500 km. apart. C. P. B.

1687. *Determination of Direction of Flow.* **Schuster.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 1733–1738, Oct. 8, 1910.)—Describes, giving mathematical theory, a method of determining the direction of flow of a liquid stream by means of Pitot tubes. A. W.

1688. *Solution of a System of Differential Equations occurring in the Theory of Radio-active Transformations.* **H. Bateman.** (Cambridge Phil. Soc., Proc. 15. pp. 423–427, June 14, 1910.)

1689. *Mechanical Principles of Brennan's Mono-rail Car.* **H. T. Eddy.** (Frank. Inst., Journ. 169. pp. 467–485, June, 1910. Eng. Rev. 23. pp. 82–91, Aug., 1910.)

1690. *Elementary Theory of the Gyroscope in the Brennan Mono-rail Car.* **E. V. Huntington.** (Eng. News, 64. pp. 68–70, July 21, 1910.)

1691. *Wave-making Resistance of Ships: a Study of Model Experiments.* **T. H. Havelock.** (Roy. Soc., Proc. Ser. A. 84. pp. 197–208, Sept. 15, 1910.)

1692. *The Eiffel Aero-dynamometric Installation.* (Engineer, 110. pp. 134–136, Aug. 5, 1910.)—An illustrated description of Eiffel's new experimental installation. The employment of stationary surfaces in a current of air is now resorted to [compare Abstract No. 706 (1908)].

1693. *Conservation of Hailstones and Investigation of their Microstructure.* **B. Weinberg.** (Science, 32. pp. 214–216, Aug. 12, 1910.)—Illustrated description of refrigerating chamber and of the method by which a thin section of a hailstone can be obtained for microscopic examination.

1694. *Rigid and Approximate Determination of the Moon's Phase.* **L. Weinek.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 337–350, March, 1910.)

1695. *Stellar Parallax.* **F. L. Chase, M. F. Smith,** and **W. L. Elkin.** (Astronom. Observatory of Yale Univ., Trans. Vol. 2. Part 2, 1910. Nature, 84. pp. 433–434, Oct. 6, 1910. Abstract.)—The paper gives the parallax investigations of 35 selected stars observed at the Yale Observatory. This new material falls into two classes, one containing stars having a larger annual proper motion than about 0·4'', the other selected stars in the Pleiades. C. P. B.

1696. *Inertia in Relative Motions.* **Delemer.** (Annal. Soc. Sci. de Bruxelles, 34. 3 and 4. pp. 241–246, 1910.)—Describes the motion of a ball relative to plane or curved surface which is in rotation. E. H. B.

1697. *Stability of Superposed Streams of Viscous Liquids.* **W. J. Harrison.** (Phil. Mag. 20. pp. 493–501, Sept., 1910.)—Mathematical.

1698. *Precise Effect of Radial Forces in opposing the Distortion of an Elastic Sphere.* **J. Prescott.** (Phil. Mag. 20. pp. 437–443, Sept., 1910.) **A. E. H. Love.** (Ibid. pp. 443–444, Sept., 1910.)

1699. *Meteorology of the Weddell Quadrant and Adjacent Areas.* **R. C. Mossman.** (Roy. Soc. Edinburgh, Trans. 47. 5. pp. 103–135, 1909.)

1700. *Limits of Oblateness of a Rotating Planet.* **P. Lowell.** (Phil. Mag. 19. pp. 700–712, May, 1910.)

1701. *Temperature and Stellar Magnitude.* **J. v. Hepperger.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 197–205, Feb., 1910.)—Working with a modification of Planck's law, the temperatures of a series of stars are computed from their assumed magnitudes. The table of resulting temperatures also includes the spectral class of each star for comparison. C. P. B.

LIGHT.

1702. *Influence of Pressure on the Absorption of Infra-red Rays by Gases.* **Eva v. Bahr.** (Ann. d. Physik, 33. 3. pp. 585–597, Sept. 22, 1910.)—The absorption of infra-red rays by gases increases in general when the gas pressure is increased by adding another gas [see Abstracts Nos. 224, 1868 (1909)], but the max. absorption is reached at different pressures, ranging from 500 mm. for CS_2 to more than 5 atmos. for CH_4 and CO. The continued experiments concern SO_2, HCl, NO_2, ozone, benzene, and methyl alcohol. Similar differences are observed; in SO_2 the max. absorption is attained at 400 mm., in HCl the rate of increase is still the same at atmospheric pressure as at low pressures, while in the other cases the maximum seems to be approached at atmospheric pressure. It would appear that a gas having large molecules attains its maximum of absorptive power at lower pressures than a gas with small molecules; the order of the gases examined is about the same as that of their molecular radii r, calculated from $\sqrt{(m/\eta)}$, where m is the molecular weight and η the internal friction, according to the tables of Landolt and Börnstein; CS_2 does not fit into this order, however. There is, in the case of N_2O, at any rate, a qualitative variation in the pressure-increase, important only at low pressures, in addition to the quantitative variations. The observation might be explained by the assumption that the absorption-bands of N_2O consist, at low pressures, of fine lines which broaden and coalesce already when the pressure is raised to 50 mm. H. B.

1703. *Dispersion by Metals in the Visible Spectrum.* II. **C. Zakrzewski.** (Acad. Sci. Cracovie, Bull. 4a. pp. 116–125, April, 1910.)—The first part of the paper deals with the measurement of the ellipticity of a convergent beam reflected from a metallic mirror. Two spectrometers are placed with their axes at a known angle; the eyepiece is removed from one spectrometer and the slit from the other. A monochromatic beam of light enters the slit, is polarised in the first instrument and reflected from the metal mirror into the second instrument which contains a compensator and analyser. Examination of a dark band seen in the analysing nicol with suitable adjustment of the compensator, furnishes the elements of ellipticity of the light. Data are given for measurements made with a cobalt mirror, the refractive index and extinction coefficient for Na-light being 2·25 and 3·98 respectively. In the second part, the dispersion of graphite is examined by the above method and its electrical conductivity is deduced from electromagnetic theory by v. Wartenberg's method [see Abstracts Nos. 548 and 816 (1910)]. G. E. A.

1704. *Calculation of Interference Fringes.* **W. Möbius.** (Ann. d. Physik, 33. 1. pp. 79–133, Aug. 5, 1910.)—Deals with Mascart's simple method of calculation and its application to diffraction phenomena in the rainbow and the ultra-microscope. Shows that when a concave wave surface passes through a focus there is a real anomaly of phase, as distinct from the theoretical anomaly which has to be applied to calculation based upon Huyghens' principle in the form given to it by Fresnel. The author proceeds to deduce Mascart's method from Huyghens' principle in its more rigid form given by Kirchhoff, and to determine its limits of application in various selected cases, The essential feature of the method is the substitution, for a unipolar wave surface, of an oscillation of definite phase and "effective" amplitude proceeding from the pole. A multipolar wave surface is split up into a number of unipolar portions. It is shown that the phase anomaly has one of the following values: $\pi/4$, $\pi/8$, $\pi/2$, $7\pi/8$ or $5\pi/4$, so long as the pole does not lie in the neighbourhood of a singular point or the singular line of a surface of an order higher than the second. Otherwise none but the integration method can give trustworthy results. E. E. F.

1705. *Relation between Elasticity and Double Refraction induced by Strain in Caoutchouc.* **P. Rossi.** (N. Cimento, 20. pp. 226–237, Sept., 1910.)—The relation between the birefringence and elasticity, termed by Leick [Abstract No. 1914 (1904)] the *specific birefringence*, has been determined for caoutchouc, Konigsberger's modification of the Babinet-Biot compensator being used to measure the difference between the ordinary and the extraordinary rays. Pure Para rubber, rubber calendered with oxidised oil and wax, and rubber containing 15 per cent. sulphur, have been examined, and the ratio $(n_e - n_0)/(l/L_0)$, where $n_e - n_0$ is the difference between the extraordinary and ordinary indices relative to the D line, is found to be nearly constant only so long as the elongation produced is approximately proportional to the stretching force and the latter is increasing, the ratio diminishing as the stretching force is then decreased. The ratio $(n_e - n_0)/\log(L/L_0)$ increases as the strain is increased, and rapidly diminishes as it is reduced, but the ratio $(n_e - n_0)/(P/s)$ is more nearly constant whether the strain is increased or diminished. W. H. St.

1706. *Optical Constants of some Substances exhibiting the Magneto-optical Kerr Phenomenon.* **St. Loria** and **C. Zakrzewski.** (Acad, Sci. Cracovie, Bull. 6a. pp. 278–286, June, 1910.)—In a former investigation [see Abstract No. 515 (1906)] of the magneto-optical Kerr-effect in ferromagnetic substances, one of the authors found, in the visible spectrum, a change of sign in the rotation of the plane of polarisation such as Ingersoll found in the infra-red. The present work was undertaken in order to complete the former by examining whether, in the curve of the Kerr-effect, the situation of the points of inversion of sign bears any relation to the curve of ordinary dispersion for the substances examined, namely magnetite, invar and copper ferrite. Measures were made of the elements of ellipticity of parallel light reflected at a mirror of each material. The ferrites show the change of sign in the visible spectrum, but invar shows no change of sign in this region. A. E.

1707. *Optical Properties of Liquid Crystals.* **E. Dorn.** (Phys. Zeitschr. 11. pp. 777–780, Sept. 15, 1910.)—Measurements of refractive index by a total reflexion method were made for wave-lengths Li 6708, Na 5893, Hg 5461 and 4357, with liquid crystalline substances enclosed as films between glass prisms of suitable angle. Two derivatives of cinnammic acid gave the following figures for the refractive indices for the ordinary and extraordinary rays:—

$$\lambda = 5893 \quad \begin{cases} n_0 = 1{\cdot}552 \text{ at } 45^\circ,\ 1{\cdot}571 \text{ at } 59^\circ \\ n_e = 1{\cdot}809 \text{ at } 45^\circ,\ 1{\cdot}751 \text{ at } 59^\circ \end{cases}$$

$$\begin{cases} n_0 = 1{\cdot}529 \text{ at } 86^\circ,\ 1{\cdot}546 \text{ at } 116^\circ \\ n_e = 1{\cdot}838 \text{ at } 86^\circ,\ 1{\cdot}756 \text{ at } 116^\circ, \end{cases}$$

the values for the ordinary and extraordinary rays converging at the higher temperatures towards the values for the isotropic liquids. In the case of cholesteryl propionate both refractive indices decrease with rising temperature, but in such a way as to converge upon the values for the isotropic phase, which are intermediate in magnitude and have an intermediate temperature-coefficient; the ordinary ray has the greater refractive index, so that the double refraction is in this case negative—a phenomenon that does not appear to have been observed in any of the many substances hitherto examined. [See also next Abstract.] T. M. L.

1708. *Optical Investigations of an Optically-active Liquid-crystalline Substance.* **F. Stumpf.** (Phys. Zeitschr. 11. pp. 780–784, Sept. 15, 1910.)—The substance examined—a derivative of (active) amylcinnamate—exists in two liquid crystalline forms, only one of which was specially examined. Its refractive index was measured between 75° and 95° for both rays; the ordinary ray shows a lineal increase with temperature, the extraordinary ray a more rapid increase, the values approximating towards one another and towards that of the isotropic phase as the temperature is raised [compare E. Dorn, preceding Abstract]. A mixture of one part of the ester with ⅓ part of cyanobenzalanisidine can be examined at ordinary temperatures and showed anomalous rotatory dispersion, the rotation falling from 86,000° in the violet to 15,000° in the green, and rising in the red to 19,000° at 20° C.; at 80° C. the minimum rotatory power is 4500°, at wave-length 6500. The pure ester shows a max. absorption in the yellow; the rotatory power is of opposite sign on either side of the absorption-band, and on the violet side of the band shows the same type of anomalous dispersion as in the case of the mixture referred to above. T. M. L.

1709. *Radiation Pressure Effective on Smallest Particles.* **G. W. de Tunzelmann.** (Phil. Mag. 20. pp. 538–540, Sept., 1910.)—It has been pointed out by Schuster [see Abstract No. 1511 (1909)] that there is a widespread impression that light-pressure acts only on particles the linear dimensions of which include several wave-lengths of light; but this is not correct. It is pointed out that the momentum, which Poynting associates with the incident beam, is destroyed whether the molecules act as scattering or absorbing centres. The cases of plane waves normally incident upon a perfectly black body and a perfect reflector, are capable of simple treatment by elementary mathematical methods [see Drude's *Lehrbuch der Optik,* p. 447, or English edition, p. 488; also J. Larmor's article *Radiation*, supplement to *Encyclopædia Britannica*]. The subject is treated on these lines in the author's *Electrical Theory and the Problem of the Universe,* a more general analytical investigation being given in Larmor's *Æther and Matter.* It is shown in chaps. vii. and viii. of the latter work that Maxwell's equations of electric force are not applicable to the investigation of problems in which radiation is important. These equations are derived from an electrodynamic stress-formula in which the function of a uniform dielectric is regarded as merely to transmit the forces without adding anything to them. In the light of present knowledge, which is most completely formulated in terms of the electron theory, any material dielectric must be regarded as susceptible of polarisation analogous to that of a magnet. Now, while in metallic conduction the current arising from this polarisation is usually negligible in comparison with the total; in radiation it forms an important part of the total current. Hence the theory of radiation pressure developed by K. Schwarzschild and published in 1901 is invalid, since the existence of the polarisation current was not recognised. J. W. Nicholson in his paper "On the Size of Tail-particles in Comets,

&c." [see Abstracts Nos. 1107 and 1108 (1910)], is here stated to rely largely on Schwarzschild's results. Hence it appeared advisable to draw attention to this unsoundness in some prominent way. **E. H. B.**

1710. *Magnetic Line Spectra of β-Rays.* **O. v. Baeyer** and **O. Hahn.** (Phys. Zeitschr. 11. pp. 488–498, June 1, 1910.)—This research was undertaken to decide whether the β-rays of radio-active substances, which are absorbed according to an exponential law, are characterised by a single velocity and are homogeneous, or are complex and possess various velocities. The magnetic deviation of the β-rays was observed, and the result was obtained that not only the α-rays, but also the β-rays, leave the radio-active atom with a distinctive and characteristic velocity. Thus the hypothesis of Hahn and Meitner arrived at from absorption measurements, that those β-rays which are absorbed according to an exponential law are homogeneous is confirmed. The magnetic deviation method affords a means of investigating products which send out β-rays of small penetrating power. The line-spectra method serves also to determine accurately the velocity of individual β-rays. **J. J. S.**

1711. *Absorption Spectra of Sulphur Vapour at Different Temperatures.* **J. I. Graham.** (Roy. Soc., Proc. Ser. A. 84. pp. 311–324, Oct. 21, 1910.)—The absorption spectra of the vapour were photographed at temperatures varying from 580° up to 900° C. at atmospheric pressure, and at constant temperatures under pressures reduced down to about 10 mm. of mercury. The photographs at constant pressure with the above variation of temperature show the presence of two distinct absorption spectra, which undoubtedly correspond to two definite molecular complexes. These two spectra are attributed to the oscillations of the S_8 and S_2 molecular systems, the former producing, by taking up vibrations of certain frequencies, a series of absorption bands between frequency *n* 2000 and *n* 2600, and having max. absorption about *n* 2500, whilst the relatively lighter S_2 system, by taking up vibrations of greater frequencies, produces a series of bands lying between *n* 2900 and *n* 3820, with max. absorption about *n* 3750. Moreover, since only two distinct spectra are evident, it is concluded that the equation $S_8 = 4S_2$ represents the sole reaction that occurs in the dissociation of sulphur-vapour on heating from its boiling-point, 448°, up to about 900° C. The interpretation of the photographs of the absorption spectra at different (constant) temperatures, but with reduction of pressure, shows that above 580° the dissociation of the molecule S_8 is simple, that is to say, there is direct (and complete) dissociation into S_2 molecules, but at or below 520° the dissociation takes place with the formation of molecules intermediate in complexity between the above two aggregates. **A. W.**

1712. *Spectrum of Oscillatory Discharge.* **P. Joye.** (Annal. Chim. Phys. 21. pp. 148–197, Oct., 1910. Extract from thesis, Fribourg Univ.)—The objects of the work described in this paper were (1) to fix the electric conditions of the oscillatory spark, and (2) to study the effect of the variation of these conditions on the spectra of different metals. The spark conditions were investigated in both oxygen and hydrogen, and the effects in the two cases showed several peculiarities which led to a comparative study of the spectra of the different metals under similar conditions in the two gases. The pressure of the gas was always about that of the atmosphere. Researches were carried out with the metals Cd, Zn, Pb, Sn, Cu, Ag, Ni, and Pt. The spark length was always 1 mm. and the photographs of the spark spectrum had an exposure of 5 sec. for the oxygen and 20 sec. for the hydrogen. The study of the influence of self-induction on the intensity of spectral lines by Berndt, Hemsalech, Néculcéa has shown the existence of a relation between the value of the self-inductance and the disappearance of the lines; but this relation is not definite, for Joye shows that, according to the electric conditions of the circuit, the same lines do not disappear for the same self-inductances. It appears that the discrepancies in the results of previous workers can be satisfactorily explained by taking the max. current intensity as an index of the electric conditions. The measurement of the constants of the circuit ought to be made with high-frequency currents; the author shows that errors are introduced by taking the values given by the ordinary methods. In the present research the methods recently developed in wireless telegraphy were employed. With a few exceptions, which are noted, the spark lines of the first four metals studied (Cd, Zn, Sn, Pb) can be divided into lines common to the arc and the spark, and lines found only in the spark. Whatever the nature of the surrounding gas, the arc lines are relatively little affected by diminution of the current intensity. The spark lines are, on the contrary, much affected. The series of Kayser and Runge and the harmonic relations in the spectra of some metals serve as a basis for a classification of the lines; this is done for Zn and Cd, Pb and Sn. The triplets of Zn and Cd belong to the arc; the doublets of the same metals, as well as some reversed lines indicated, behave in a characteristic manner. Ag and Cu have similar spectra and cannot be classified in the above manner. The ideas of arc lines and spark lines are quite insufficient to effect the classification of the lines. The series of these metals is as yet too little known to be of any use. The same remarks apply to the spectrum of Ni. In Pt some lines have been arranged with harmonic relation, but no more general relations have been found. The surrounding gas has an effect on the intensity of metallic lines: some lines, a small number, are stronger in hydrogen than in oxygen; these are usually due to impurities, in particular the lines of carbon. In hydrogen the lines of metals are sharper, much finer, and less intense than in oxygen. Metals with high melting-points, such as Ag, Cu, Pt, Ni, have many less lines which persist, at feeble current intensity, in hydrogen. None of the lines of the second spectrum of hydrogen were found; the strong and broad lines of the first spectrum diminish in intensity and become much narrower with small current intensities. The latter part of the paper deals with the reply of Berndt to the criticisms of Hemsalech and Néculcéa. A. W.

1713. *Zeeman-effect for Emission Lines oblique to the Lines of Force.* **G. J. Elias.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 391–394, Oct. 27, 1910.)—The theory of this effect was developed by Lorentz [see Abstract No. 76 (1910)]. The rays from an intense electric spark were passed through or near the pole-pieces of a du Bois electromagnet [see Abstract No. 1760 (1910)], and a large Rowland grating was used as spectroscope. The state of polarisation of the emitted light was examined by means of a quarter-wave plate, most of the measurements being made with the line 520·620 of the Cr spectrum. The experimental results agree in most respects with the theory. G. E. A.

1714. *Studies in Luminescence.* XII. *Absorption of Alcoholic Solutions of Eosin and Resorufin.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 31. pp. 376–380, Oct., 1910.)—There is reason to believe that in fluorescent solutions the fluorescence is a property of the ion. It is therefore of interest to determine whether the absorption of these solutions is also an ionic property, or partly due to the undissociated substance. In order to throw light upon this question, the authors have determined the coefficient of absorption of eosin and resorufin in both dilute and concentrated solutions, for wave-lengths throughout the absorption band. If the absorption is partly due to the undissociated molecules, some change in the form of the absorption curve should result from change in concentration. The method used was to compare the intensity of monochromatic light transmitted by a cell containing pure alcohol, with the intensity when the cell was filled with the solution. An acetylene flame served as source. The absorption curve is found to have very nearly the same form for the dilute and concentrated solutions, indicating that the form of the curve is not altered by concentration, especially in the case of resorufin, thus confirming Miss Wick's result [Abstract No. 1154 (1907)]. The curve for resorufin suggests that the band is complex, with secondary maxima at 0·558 and 0·586 μ, besides the principal maximum at 0·577 μ. In eosin there is indication of a secondary maximum at 0·49 μ. There is some doubtful indication that this secondary band changes with the concentration at a different rate from the principal band. For each substance, the curve of energy-distribution in the fluorescence spectrum is compared with the absorption curve. A curious relationship is shown, the one curve being, roughly speaking, the image of the other. The absorption curve is steep towards the red and gradual towards the violet, while the fluorescence curve is gradual towards the red and stops abruptly on the violet side. [See Abstract No. 914 (1910).] A. E.

1715. *Studies in Luminescence.* XIII. *Specific Exciting Power of Different Wave-lengths of the Visible Spectrum in the case of Eosin and Resorufin.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 31. pp. 381–387, Oct., 1910.)—Fluorescence may usually be excited by light of a great variety of wave-lengths, but the intensity of the fluorescence excited by different portions of a given exciting spectrum is widely different. It is not clear whether this difference is due to the fact that certain wave-lengths are particularly effective in exciting fluorescence, or whether it results merely from the fact that the absorbing power of the material is different for different wave-lengths. Light cannot produce excitation unless it is absorbed by the fluorescent solution. The authors have investigated the question whether the fluorescence excited per unit of *absorbed* energy is constant for all wave-lengths. The exciting light was a Nernst glower, which took the place of the slit of a large spectrometer. A narrow region in the spectrum thus formed was used in exciting the solution studied, and the intensity of fluorescence produced was measured by a spectrophotometer as the wave-length of the exciting band was varied. The fluorescent solution was then emptied, and replaced by a piece of magnesium carbonate mounted obliquely so as to reflect light from the slit into the spectrophotometer. The intensity, and range of wave-lengths, of the light thus reflected were measured for each of the spectrometer settings previously used. Finally, the absorption of a layer of the solution of known thickness was measured for some definite wave-length. The relative reflecting power of the magnesium carbonate was separately determined throughout the region used. The observations did not include the ultra-violet region. The result arrived at is that, confining attention to the range of one absorption band, the light lying near the red side of the band is more effective in producing fluorescence than that lying on the violet side, and the change in the specific exciting power in passing along the band is continuous, without any indication of anything selective in the neighbourhood of the region of max. absorption. A. E.

1716. *Consequences of the Corpuscular Hypothesis of the γ- and X-Rays, and the Range of β-Rays.* **W. H. Bragg.** (Phil. Mag. 20. pp. 385–416, Sept., 1910.)—The paper gives a detailed account of the author's theory of γ- and X-rays, in which the γ- or X-ray is regarded as a negative electron to which has been added a quantity of positive electricity which neutralises its charge but adds little to its mass. The main argument for the theory is based on the experimental results that when γ- or X-rays are incident on a plate of matter, the distribution of the resulting β- or kathode-rays is such as should be expected if when the β-rays are first formed they simply prolong the line of motion of the γ- or X-rays, and if their subsequent movements are due to the usual scattering which β-rays undergo. Again, the speed of the β- or kathode-particle which is caused by a γ- or X-ray, is independent of the nature of the atom in which it originates, but is directly connected with the quality of the γ- or X-ray. Thus the author gets the conception of the complete disappearance of a γ- or X-ray with the simultaneous creation of a β- or kathode-particle, which may in its turn be re-converted into a γ- or X-ray. In the case of the X-ray, for example, the energy alternates between the kathode-particle state and that of the X-ray; being gradually frittered away by ionisation in the kathode-ray state, but diminishing little or not at all in the X-ray state; the author concluding, from experiments described, that the X- or γ-rays are of themselves incapable of ionising. On this hypothesis there is no true secondary radiation, and the author criticises the conclusions of McClelland, who assumed a secondary radiation to be produced in the case of the reflection of β-rays by a plate of matter [Abstract No. 1488 (1908)], and shows that all the results can be explained as simple scattering. The author calculates the relative ranges of β-particles in various substances (the range being defined as the total length of track when straightened out) and finds that the whole track of a β-particle in Pb is greater, weight for weight, than in Al; this being due to the greater amount of turning-back caused by the Pb atoms than by the lighter atoms of Al. The results of Barkla [see Abstract No. 1954 (1908)], &c., on the homogeneous secondary radiation characteristic of metals are explained on the corpuscular or "entity" hypothesis by assuming that there is a critical speed for kathode-rays in metals below which X-rays cannot be formed, this critical speed being different in different metals and increasing with the atomic weight. E. M.

1717. *Influence of Temperature in Radio-active Transformations.* **H. W. Schmidt** and **P. Cermak.** (Phys. Zeitschr. 11. pp. 793–800, Sept. 15, 1910.)—The result of this experimental research is that the γ-radiation of RaC is not changed by heating the preparation to about 1300°. There is accordingly no ground for the assumption that the rate of transformation of RaC or of one of its series is affected by temperature [see Abstract No. 71 (1909)]. E. H. B.

1718. *Emanation given off by Salts of Radium.* **L. Kolowrat.** (Le Radium, 7. pp. 266–269, Sept., 1910.)—Previous experiments have shown that the amount of RaEm absorbed by a radium salt at a given temperature is given by the expression $C(1-e^{-\lambda t})/\lambda$, where λ is the ordinary radio-active constant of RaEm, and C is a constant less than unity. This constant has been found to be the same for the same specimen of material containing Ra, but it varies in an anomalous way with different specimens. It apparently decreases—*i.e.*, the amount of emanation given off increases with increase of impurity, but it is affected by other variable conditions. The hypothesis of solid solution does not appear to be a satisfactory explanation of its variation. For a given specimen and a given temperature the constant has been found to be the same, whether or no the temperature in question has been kept up since the commencement of accumulation of the emanation. Experiments were also made with pure $RaCl_2$ deposited on Pt. It was found that the amount of emanation given off increased with temperature up to 1320° C., but heating to a higher temperature appeared to produce an infusible chemical modification of the $RaCl_2$, so that it gave off less emanation than formerly at any temperature, while it was impossible to wash it from the Pt. Barium chloride or bromide containing a little Ra did not show this effect, practically all the emanation being given off on fusing the salt. E. M.

1719. *Determination of Penetrating Radiation on the Eiffel Tower.* **T. Wulf.** (Phys. Zeitschr. 11. pp. 811–813, Sept. 15, 1910.)—Gockel has concluded that the penetrating radiation producing ionisation in the atmosphere does not decrease very much with increasing height above ground-level [Abstract No. 958 (1910)], while Bergwitz avers that the effect is very marked. The author has made experiments on the Eiffel Tower (300 m.), and in a series of measurements found the number of ions produced by the penetrating radiation at the top of the tower to be 3·5 per cm.^{3} per sec., while at the foot the number was 6, and at Valkenburg 10. If it is assumed that the γ-rays are reduced to half their intensity in 80 m. of air, then the slow fall of the effect of the penetrating radiation requires further explanation. The author does not consider that the effect in his experiments was influenced by any active deposit on the tower itself. E. M.

1720. *Ratio between Uranium and Radium in Minerals.* **F. Soddy.** (Nature, 84. pp. 296–297, Sept. 8, 1910.)—The paper deals with the question of the ratio of Ur to Ra in autunite—a mineral which previous experiments have shown contains less Ra than the equilibrium amount for the Ur-content [see Abstract No. 1610 (1910), &c.]. The author has made dual measurements of the Ra-Ur ratio and He-content of different specimens of the mineral, and finds results which vary widely among the specimens examined. Taking the few results so far obtained as representative, the Ra ratio decreases to a minimum and then rises more slowly as the He-content increases. This suggests that when the autunite was first formed the Ra, but not its parent (ionium), separated out with the Ur, this being probable owing to the isomorphism of Ra and Ca. This hypothesis would show that autunite has been very recently laid down, and that the ages indicated by the He-content are not very far from the truth. E. M.

REFERENCES.

1721. *Absorption and Fluorescence of Rubidium Vapour.* **T. S. Carter.** (Phys. Zeitschr. 11. pp. 632–633, July 15, 1910.)

1722. *Employment of Quarter-wave Plates and Apparatus for Monochromatic Radiation.* **A. Cotton** and **H. Mouton.** (Annal. Chim. Phys. 20. pp. 275–283, June, 1910.)—This article forms a note to a previous paper by the authors on magnetic birefraction of liquids [see Abstract No. 809 (1910)].

1723. *Incidence of Light upon a Transparent Sphere of Dimensions Comparable with the Wave-length.* **Rayleigh.** (Roy. Soc., Proc. Ser. A. 84. pp. 25–46, June 9, 1910.)—Following the author's application in 1881 of Maxwell's equations of the electromagnetic field to the disturbance produced by an obstacle on plane waves of light, the author now treats the subject by spherical harmonic analysis, adding tables and graphs as to effects produced on the assumption of certain definite numerical data. These include the refractive index 1·5 (or dielectric constant 2·25), the circumference of the sphere equal to the wave-length of the light $\eta=1$, also larger spheres for which $\eta=1\cdot5$, 1·75, 2, 2·25. E. H. B.

1724. *The Light of the Firefly.* **E. Thomson, W. W. Coblentz.** (Electrical World, 56. pp. 1012–1013, Oct. 27, 1910.)—[See Abstract No. 812 (1910).]

1725. *Photographic Photometry.* **C. F. Brush.** (Phys. Rev. 31. pp. 241–251, Sept., 1910. Paper read before the Amer. Assoc. for Advancement of Science, Dec. 29, 1909.)—The author outlines a method of obtaining comparison patches from a definite light source placed at a given distance from a photographic plate. Several of the difficulties encountered are investigated, including effect of temperature, time of development, and a phenomenon which is styled "after action," corresponding to inertia, whereby the full sensitiveness is not attained until after a certain minimum exposure depending on the type of plate. C. P. B.

1726. *Theory of Double Refraction induced by an Electric or a Magnetic Field.* **L. Natanson.** (Acad. Sci. Cracovie, Bull. 6a. pp. 256–277, June, 1910.)—The object of the paper, which is too mathematical for abstraction, is to discuss and, if possible, expand the existing theories relating to the Kerr-effect and to its magnetic analogue discovered by Cotton and Mouton in 1907. The work of Voigt, Havelock, Larmor, Skinner, and others is referred to. While recent researches have revealed many important results, yet we are only beginning to gain an insight into the phenomenon. To form a complete and really adequate representation of its working is a task apparently much beyond our present range of knowledge. A. E.

1727. *Refraction and Dispersion of Argon and Redeterminations of the Dispersion of Helium, Neon, Krypton, and Xenon.* **C. Cuthbertson** and **M. Cuthbertson.** (Roy. Soc., Proc. Ser. A. 84. pp. 13–15, June 9, 1910.)—[See Abstracts Nos. 441 (1909) and 361 (1910).]

1728. *Rotatory Power of Quartz, Cinnobar, and Nicotine at Low Temperatures.* **F. A. Molby.** (Phys. Rev. 31. pp. 291–310, Sept., 1910.)—Previous measures of the rotatory power of quartz, through a range of temperatures from 25° to —190° C., indicated that the temperature-effect is slightly larger for the shorter wave-lengths of the visible spectrum than for the longer. The repeated work leads to the same conclusion, though the difference is so small that very refined measurements are required to establish its existence. A. E.

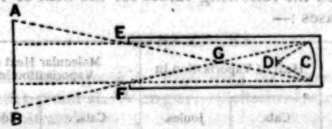
1729. *Significance of Temperature in the Case of Radiation.* **H. Kayser.** (Zeitschr. wiss. Phot. 8. pp. 151–156, March, 1910.)

1730. *Wave-length Measurements in the Visible Region of the Arc Spectrum.* **J. M. Eder** and **E. Valenta.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 519–613, April, 1910.)—A continuation of former work [see Abstracts Nos. 102, 1271, 1272 (1910)]. The grating measurements of the lines of the following elements are given: Al, Sb, Ba, Be, Pb, Cs, Ca, Cassiopeium, Ce, Cr, Ga, Ir, K, C, Cu, La, Mn, Mo, Na, Nd, Cb, Os, Pd, Pt, Pr, Hg, Rh, Rb, Ru, Sc, Sr, Ta, Th, Ti, U, V, Bi, W, Y, Zn, Sn, Zr. E. H. W.

1731. *Phosphorescent Salts of Cadmium with Sodium.* **C. W. Waggoner.** (Phys. Rev. 31. pp. 358–366, Oct., 1910.)

HEAT.

1732. *New Radiation Pyrometer.* **C. E. Foster.** (Amer. Electrochem. Soc., Trans. 17. pp. 223–227; Discussion, pp. 227–228, 1910.)—Radiation pyrometers are of two classes, "optical" and "total radiation," of which the latter is the more suitable for works' practice on account of it dealing with the whole range of visible and invisible heat radiations. The author has designed the "fixed focus" type of instrument shown diagrammatically in the sketch. A fixed proportion of the radiant heat entering the aperture EF strikes the mirror C and is brought to a focus at D, where a small thermo-junction is placed. In order that the radiations from the hot body shall fill the aperture EF as seen from the mirror C, the hot body must fill or overlap the cone GAB. Having found G, therefore, the maximum working distance between the hot body and the apex of the cone, must be a fixed multiple of the smallest dimension of the hot body. The multiple has been fixed at 10, and the method of using the instrument on a steel billet of 6-in. side is to fix the pyrometer at a distance not exceeding 60 in., so that the axis of the tube is in line with the centre of the billet. The temperature is then indicated by connecting the thermo-couple to a milliammeter previously calibrated according to the Stefan-Boltzmann law of radiation. Since the cold junction is only 4 mm. from the hot junction, variations in the temperature of the instrument affect both junctions alike, and consequently the readings are independent of the instrument temperatures. F. C. A. H. L.



1733. *Conductivity for Heat of Pulverulent Bodies.* **M. Smoluchowski.** (Acad. Sci. Cracovie, Bull. 5b. pp. 129–158, May, 1910.)—The author has determined the heat conductivity of quartz sand, powdered quartz, zinc dust (coarse and fine), coarse and fine iron powder, pulverised zinc, emery powder, lycopodium, rice powder, copper oxide, lampblack, Liège powder, and diatomaceous earth. These fall into the classes of granular powders and spongy powders. In the case of the former class the relation between conductivity and pressure of gas enclosed between the grains is given by the expression $\kappa = f(\epsilon p)$, where κ is the conductivity, f is a function (unknown), the same for all powders, and ϵ a constant, which differs for the different substances. A mathematical consideration leads to the expression $\kappa = A \log(1 + \epsilon p)$, where A will depend on the arrangement of the grains. The conductivity of the powdered substances depends essentially on the nature of the gas contained in the interstices. For a given gas and given pressure it is, as a rule, less for a powder with the smallest particles, and for a given powder it decreases as the pressure of the gas diminishes. For "spongy" powders the simple laws given above do not hold. A. F.

1734. *Influence of Magnetisation on the Thermal Conductivity of Iron and Steel.* **U. Bordoni.** (N. Cimento, 20. pp. 159–211, Sept., 1910.)—A most careful investigation of the thermal conductivities of rods of iron and steel before and after magnetisation, between temperatures of 12° and 110°, and for intensities of magnetisation up to 1700 c.g.s. units for iron and 1500 units for steel, shows that longitudinal magnetisation produces a very slight, but distinct, diminution in the longitudinal thermal conductivity of the rod, and that the sign of the magnetisation has no influence on the sense of the thermal phenomena. The diminution is greater for iron than for steel, and increases more rapidly with rise in the intensity of magnetisation. The measurements were made on bars surrounded by a hot-water jacket, the temperatures being measured electrically by the use of couples of brass-Cu, Fe-Cu, and Ag-Cu. W. H. Sr.

1735. *Heat of Vaporisation of some Liquefied Gases.* **T. Estreicher** and **A. Schnerr.** (Acad. Sci. Cracovie, Bull. 7a. pp. 345–348, July, 1910.)—The authors have obtained the following values for the heat of vaporisation of the different liquefied gases :—

Gas.	Temperature.	Heat of Vaporisation in		Molecular Heat of Vaporisation in		Trouton's Constant.
		Cals.	Joules.	Cals.	Joules.	
SO_2	−11·16°	95·3	398·9	6106·7	28,286	23·3
HJ	−37·2	33·94	142·0	4331·85	18,124	18·5
HBr	−69·86	48·68	203·7	3939·1	16,481	19·4
HCl	−84·80	98·75	413·2	3600·8	15,064	19·1
Cl_2	−33·8	61·9	259·0	4371·9	18,292	18·4
NH_3	−33·4	321·3	1343·8	5461·9	22,853	22·75
H_2S	−61·37	131·98	5522·0	4494·8	18,806	21·3

[See also Abstract No. 1441 (1904)]. A. F.

1736. *Specific Heats of Elements at Low Temperatures.* **T. W. Richards** and **F. G. Jackson.** (Zeitschr. Phys. Chem. 70. pp. 414–451, 1910.)—The authors describe the earlier determinations of the specific heats of elements at low temperature, and have worked out a method for obtaining concordant and reliable results for the specific heats of 25 elements between the temperature of liquid air and room temperature. The cooling vessel consisted of a Dewar flask into which a double brass jacket was fitted. Two glass tubes passed into this brass vessel, one ending near the bottom, the other just below the top. These tubes served to carry off the evaporating air during the cooling, and also, when the apparatus was inverted, for transferring the substance to the calorimeter. The calorimeter consisted essentially of a modified Berthelot calorimeter thoroughly protected from radiation. The Beckmann thermometers were all carefully calibrated, and the temperatures referred to the international hydrogen scale. The low temperatures were measured by a pentane thermometer. Special precautions were taken to prevent error being introduced by transferring the substance from the cooler to the calorimeter. The results obtained as the mean of many separate determinations in each case, for temperatures between liquid air and room temperature, are : Carbon (graphite), 0·0959 ; Mg, 0·208 ; Al, 0·175 ;

Si, 0·118; phosphorus, 0·169; sulphur, 0·181; Cr, 0·0794; Mn, 0·0981; Fe, 0·0859; Ni, 0·0869; Co, 0·0828; Cu, 0·0789; Zn, 0·0846; As, 0·0705; Mo, 0·0555; Pd, 9·0517; Ag, 0·0511; Cd, 0·0515; Sn, 0·0502; Sb, 0·0469; Pt, 0·0279; Au, 0·0297; Tl, 0·0296; Pb, 0·0300; Bi, 0·0284. The specific heats are expressed in terms of the 20°-calorie. All these elements, except those with the lowest atomic weights, conform approximately to Dulong and Petit's law. F. J. B.

1737. *Calorimetric Investigation of Chlorine at Low Temperatures.* **T. Estreicher** and **M. Staniewski.** (Acad. Sci. Cracovie, Bull. 7a. pp. 349–351, July, 1910.)—The specific heat of liquid Cl between −80° and +15·41° is 0·2280. The specific heat of solid Cl between −192° and −108° is 0·1446 cal. From this the atomic heat is 5·18. Taking −108·5° as the melting-point of solid Cl, the authors calculate the heat of fusion to be 22·96 cals. An error of 1° in the melting-point brings about an error of 0·078 cal. in the heat of fusion. A. F.

REFERENCES.

1738. *Ventilated Thermograph for Registering the Internal Gas Temperature of Balloons.* **G. Rempp** and **R. Wenger.** (Zeitschr. Instrumentenk. 30. pp. 308–310, Oct., 1910.)—Illustrated.

1739. *Theory of Transpiration, Diffusion, and Thermal Conduction in Rarefied Gases.* **M. Smoluchowski.** (Acad. Sci. Cracovie, Bull. 7a. pp. 295–312, July, 1910.)—A mathematical paper in which a formula is obtained for the flux of heat in rarefied gases. A. F.

1740. *On Entropy.* **W. S. Franklin.** (Phys. Rev. 30. pp. 766–775, June, 1910.)—Discusses a class of irreversible processes which are permanent or steady, and also an apparent close relationship between entropy and time. L. H. W.

1741. *Conditions Necessary for Discontinuous Motions in Gases.* **G. I. Taylor.** (Roy. Soc., Proc. Ser. A. 84. pp. 371–377, Oct. 21, 1910.)—A mathematical discussion.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY

1742. *Charge of an Electron.* **L. Begeman.** (Phys. Rev. 31. pp. 41–54, July, 1910.)—Wilson's cloud method was used, but radium was substituted for Röntgen rays as an ioniser. Most of the clouds were produced by a slow expansion. Under such conditions practically all the drops in the cloud carry double charges. They are, at all events, the larger ones in the cloud, and tend to accumulate moisture at the expense of the smaller ones. Thus any evaporation is compensated by the accumulation of moisture in falling through a mass of singly charged droplets. The field used to balance the gravitational field was one of 2800 volts/cm. The value deduced for *e* was: From singly charged droplets, $4{\cdot}669 \times 10^{-10}$ e.s.; from doubly charged droplets, $4{\cdot}686 \times 10^{-10}$; from multiply charged droplets, $4{\cdot}650 \times 10^{-10}$; giving a final mean of $4{\cdot}668 \times 10^{-10}$ e.s. unit. E. E. F.

1743. *Determination of Ratio of Mass to Weight for a Radio-active Substance.* **L. Southerns.** (Roy. Soc., Proc. Ser. A. 84. pp. 325–344, Oct. 21, 1910.)—The experiments described are the result of the following consideration given by J. J. Thomson [Brit. Assoc., Winnipeg (1909); see also Abstract No. 891 (1908)]: An electrified sphere has attached to it a mass of ether proportional to its potential energy such that if the mass were to move with the velocity of light, its kinetic energy would equal the electrostatic potential energy of the particle. This result can be extended to any electrified system, and thus a part of the mass of any system is proportional to its potential energy. If the ether were not subject to gravitational attraction, this part of the mass would add nothing to the weight of the body, and even if the ether were ponderable we might expect that, as the mass is swimming in a sea of ether, it would not increase the weight of the body to which it is attached. But if it does not, then the weight of a given mass of a body may be less than that of an equal mass of some substance with a smaller amount of potential energy. The radio-active substances are constantly giving out large quantities of heat, presumably at the expense of their potential energy, thus: when these substances reach their final non-radioactive state, their potential energy must be less than when they were radio-active. Rutherford's measurements show that the energy emitted by 1 gm. Ra in the course of its degradation to non-radioactive matter is equal to the kinetic energy of a mass of $\frac{1}{13}$ mgm. of the ether, and if this ether does not increase the weight of the Ra, the ratio of mass to weight for Ra would be greater by 1 part in 13,000 than for its non-radioactive products. In the present paper some experiments are described to compare the ratio of mass to weight for red lead and U_3O_8; since, if Ur is the parent of Ra, it must also possess its great potential energy and great ethereal mass. Preliminary experiments were made with wire pendulums having hollow bobs of Al at the ends for the reception of the substance, but it was found impossible with this arrangement to obtain consistent results with the required degree of accuracy. Consequently a specially designed type of rigid pendulum was employed; for the elaborate details of the experiment the original paper must be consulted. The results indicate that the ratio of mass to weight for U_3O_8 does not differ from that of red lead by more than 1 part in 200,000. E. M.

1744. *The Relation between Electromagnetism and Geometry.* **H. Bateman.** (Phil. Mag. 20. pp. 623–628, Oct., 1910.)—Recent theoretical researches in electromagnetism indicate that the science of electromagnetism is closely connected with the geometry of a system of spheres. According to the generalised form of the principle of Huyghens, an electromagnetic disturbance at any point in space can be regarded as the resultant of a large number of elementary disturbances which are propagated in the form of spherical waves. The author studies the geometrical properties of an aggregate of spherical waves travelling inwards or outwards with the velocity of light. Two distinct sets of properties are dealt with. In the first place the spheres are regarded simply as geometrical figures, and their geometrical properties are studied in the usual way. In the second place, the relations between the spheres are considered when various numbers are attached to each. A complex of $(\text{infinity})^3$ representative spheres is called a view of the universe. From the equations it is shown that it is possible that the motion of a connected system of particles may be represented by a continuous conformal transformation of a hypersurface or, in particular, by a continuous deformation without stretching. The path of a particle is represented by the successive positions of a point on the hypersurface in the successive deformations. The case in which the hypersurface becomes torn during the deformation is probably irrelevant for physics, since a particle corresponding to a point at which a tear originates would divide into two. This case, however, may be of some biological interest. A. R.

1745. *Isolation of an Ion, Measurement of its Charge, and Correction to Stokes' Law.* **R. A. Millikan.** (Science, 32. pp. 436–448, Sept. 30, 1910. Abstract of paper read before the Amer. Physical Soc., April, 1910.)—A cloud of fine droplets of oil, or of mercury, or of some other non-volatile substance is blown by means of an *atomiser* (due to J. Y. Lee, 1908) over a horizontal air condenser and a few of the droplets in this cloud are allowed to fall through a pinhole in the middle of the upper plate of this condenser into the space between the plates. The pinhole is then closed to shut out air-currents. The plates are enclosed and the temperature controlled so that the air within the condenser is altogether stagnant. The droplet, once inside the condenser, is illuminated through a small window by an arc light, so that it appears in the field of an observing cathetometer telescope like a star on a black ground. This droplet falls under gravity but, before reaching the lower plate of the condenser, a field of 3000 to 8000 volts per cm. is thrown on between the plates, and, if the droplet has a charge of the right sign, it is then pulled up against gravity toward the upper plate. Before it strikes the upper plate the field is thrown off and the plates short-circuited, and the time of fall under gravity noted. The time of rise is similarly noted. This is repeated a number of times or until the droplet catches an ion from among those which exist normally in the air, or have been produced there by any of the usual ionising agents. The fact that an ion has been caught, and the exact instant at which the event happened, are signalled to the observer by the change in the speed of the droplet under the influence of the field. From the sign and magnitude of this change in speed, taken in connection with the constant speed under gravity, the sign and the exact value of the charge carried by the captured ion are determined. The error in a single observation need not exceed one-third of 1 per cent. And it is from the values of these observed speeds that all the conclusions of this research are directly deduced. It was often found that the original charge on a droplet was $34{\cdot}47 \times 10^{-10}$. This is within ¼ per cent. of exactly 7 times the charge on the positive or negative ion caught by the droplet in the observations. This initial charge was not obtained from ions in the air, but from the frictional process involved in blowing the spray. One to two hundred drops were studied which had initial charges between 1 and 150, and which were upon as diverse substances as oil, mercury, and glycerine, but in every case it was found that the *original charge* on the drop was an *exact multiple* of the *smallest charge* which the drop caught from the air. The total number of charges observed was over a thousand, and in *not a single instance* was there any charge which did not represent the advent upon the drop of *one invariable quantity of electricity*, or a very *small exact multiple* of that quantity. The final mean value obtained for e is $4{\cdot}9016 \times 10^{-10}$. It was calculated from the circumstances under which the droplet picked up an ion against its own repulsion, that the kinetic energy of agitation of a molecule is of the order of 5×10^{-14} as kinetic theory demands. For when the droplets were so charged that a greater energy than the above was required to force the ion up against the repulsion, very few, if any, ions were caught by it. The correction to Stokes' law needed to accord with these experiments was found to be possible by the insertion of the factor $(1 + \mathrm{A}l/a)$ where A is a constant and equals 0·815, l is the length of the mean free path of the gas molecule and a the radius of the droplet. Thus, the amended laws due to Stokes are then $\mathrm{X} = 6\pi\mu a v(1 + \mathrm{A}l/a)$ and $v_1 = \frac{2}{9}\,[ga^2(\sigma - \rho)/\mu](1 + \mathrm{A}l/a)$, where v is the speed of the droplet under the force X, v_1 is the terminal speed under gravity g of a droplet of density σ in a fluid medium of density ρ and viscosity μ. E. H. B.

DISCHARGE AND OSCILLATIONS.

1746. *Total Ionisation produced in Different Gases by the Kathode Rays ejected by Röntgen Rays.* **R. D. Kleeman** (Roy. Soc., Proc. Ser. A. 84. pp. 16–24, June 9, 1910.)—In the experiments gold-leaf was placed in the path of a beam of X-rays and the kathode radiation produced was completely absorbed in the gas under consideration, the direct action of the X-rays on the gas being eliminated. The total ionisations produced by these kathode rays in the different gases were found to be relatively practically the same as the total ionisations produced by α-particles, indicating that the energy necessary to ionise an atom is the same for the kathode ray as for the α-particle. The author discusses other work on the subject, in particular on the consideration of the amount of energy required to produce an ion, and the question as to whether the energy necessary to make an ion from any given atom depends on the nature of the ionising agent or on its penetrating power. [See also Abstract No. 1251 (1910).] E. M.

1747. *Typical Cases of Ionisation by Röntgen Rays.* **C. G. Barkla.** (Phil. Mag. 20. pp. 370–379, Aug., 1910.)—The author has shown [Abstract No. 380 (1909)] that many apparent anomalies of ionisation may be explained in terms of a few simple laws, and that the behaviour of one substance may be regarded as typical of all. Further experiments have confirmed these conclusions, and from the results of observations on ionisation in many gases and vapours complete regularity of behaviour has been found. It is necessary and sufficient to know the penetrating power of the characteristic secondary X-radiations emitted by the constituent elements to determine the way in which the ionisation in a gas or vapour varies with the penetrating power of the ionising radiation. In other words, it is necessary and sufficient to know the X-ray line spectra for the constituent elements. No anomalous ionisation by X-rays has been observed. A fuller account of these experiments is to be published later. J. J. S.

1748. *Production of Canal Rays.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 12. 16. pp. 661–681, Aug. 30, 1910. Phys. Zeitschr. 11. pp. 873–880, Oct. 15, 1910.)—Describes some very simple arrangements for the production of canal rays (see Abstract No. 2252 (1902)]. They may be produced by means of a kathode consisting of a single straight wire, without any slits or perforations, whose apparent necessity suggested the name which the author gave to the rays. Two wires, mounted side by side as simultaneous kathodes, give a beam normal to the plane joining the wires and proceeding in opposite directions. The section of the beam somewhat resembles the outline of the Eiffel Tower, with its base in the plane containing both wires. When three wires are mounted so as to contain an equilateral prism there are not six such beams, but only three, proceeding from the three wires respectively. When two small metallic squares are mounted facing each other, with their diagonals inclined at 45° to each other, eight beams are seen parallel to the planes of the squares, but proceeding, not from the corners, but from the points midway between them. The author believes that the canal rays are not formed of positive particles falling from some distance on to the kathode, but that they are produced in the luminous kathode layer itself, and derive their energy from it. E. E. F.

1749. *Selective Photoelectric Effects.* **R. Pohl** and **P. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 12. 16. pp. 682–696, Aug. 30, and 12. 17. pp. 697–710, Sept. 15, 1910.)—A continuation of previous work [see Abstracts Nos. 417 and 842 (1910)]. The photoelectric effects observed may be classified as "normal" and "selective" respectively. The normal effect begins at a wave-length of 500 $\mu\mu$ (the exact wave-length depends upon the electropositive character of the metal) and extends over the whole short-wave spectrum, increasing with diminishing wave-length. The selective effect is limited to a short range of wave-lengths, and shows something resembling resonance. It requires a component of the electric vector normal to the surface. The normal effect is found in all metals, including those of the alkalies, and comprises the phenomena classed under the Planck-Einstein light-unit hypothesis. The authors have separated the two effects in cells made with the liquid K-Na alloy. It is possible to prepare cells in which the selective effect is practically isolated. This is indicated by the ratio between the photoelectric currents for the two chief azimuths of polarisation, which is as high as 300 : 1 for an angle of incidence of 60°. In this selective effect the position and magnitude of the maximum depend upon the angle of incidence. The maximum is displaced by about 20 $\mu\mu$ towards the red by increasing the angle of incidence. The height of the maximum, referred to equal incident energies, steadily increases with increasing angle of incidence, and tends towards a finite value for grazing incidence. The selective effect is not a property of the alkali metal atom, but depends upon its molecular binding, as shown by the action of K in the pure state and in the amalgam. Experiments were undertaken in order to clear up the effect of the Hg in the amalgam, and the results are given in the second paper. The selective effect found in pure K at λ = 436 μμ is suppressed by the addition of 21 atomic per cent. of Hg, both in the solid and liquid phases. At concentrations ranging from 17 to 70 atomic per cent. K a new selective effect sets in, whose maximum is displaced by about 50 μμ towards the shorter wave-lengths with respect to the maximum for pure K. There are some indications of a further selective effect below λ = 313 μμ with from 5 to 10 atomic per cent. K. E. E. F.

1750. *Alteration of Discharge Potentials of Glow Discharge by Action of Röntgen Rays.* **E. Marx.** (Zeitschr. Phys. Chem. 70. pp. 277–289, 1910.)—As the result of the experiments which are described in this paper it is concluded that when the Röntgen rays are so directed that first the window of the discharge tube and then the electrode shall be struck, a rise in the discharge potentials takes place when the window is made the kathode and the electrode the anode, while a lowering of the discharge potentials takes place when the window is anode and the electrode is kathode. Such action occurs if the window and the vessel enclosing the discharge tube are kept at the same potential. These relationships can be reversed by the action of an electrostatic field between the Al window and the vessel surrounding the tube. A. E. G.

1751. *Sparking Potential at very Small Distances.* **E. H. Williams.** (Phys. Rev. 31. pp. 216–240, Sept., 1910.)—The spark takes place between a small sphere, 3–4 mm. diam., and a plane surface 2 cm. in diam. The sphere and plane are mounted on an interferometer by which the distance between the electrodes is measured down to a length of 1λ sodium light. Great care is taken that the electrodes do not yield to the electrostatic force between them, when the p.d. is applied. Distances range from 1λ to 5λ. The results show that for these very short distances the nature of the material of the electrodes has no influence on the sparking p.d. In dry air the sparking p.d. is constant at about 370 volts up to a distance of 5λ. When the distance is less than 5λ, the path of the discharge is not along the shortest distance. This is shown by photomicrographs of the plane electrode. Ionisation by ultra-violet light at once lowers the sparking p.d., which is then considerably lower for distance 1λ than for 5λ. Moisture lowers the sparking p.d. T. P. B.

1752. *Wehnelt Kathode Currents.* **K. Eisenmann.** (Deutsch. Phys. Gesell., Verh. 12. 19. pp. 725–730, Oct. 15, 1910.)—The saturation current between the hot Pt-wire, coated with CaO, and a metal cylinder surrounding the wire is measured at a certain temperature of kathode *in vacuo*, the p.d. being regulated from a 110-volt supply. The metal cylinder is then removed and the wire becomes the kathode of an ordinary vacuum tube, the kathode temperature and the vacuum being the same as before. A 2000-volt battery sends a discharge through the tube and the current is regulated by a resistance in series. The current at which the kathode-fall suddenly begins to increase [see Abstract No. 2672 (1904)] is noted. At this point the positive column just reaches the kathode, which it does not do for greater or smaller currents. This "limiting" current and the saturation current above are found to be identical in value. T. P. B.

1753. *Wave-length and Logarithmic Decrement of the Linear Electrical Oscillator.* **J. E. Ives.** (Phys. Rev. 31. pp. 185–215, Sept., 1910.)—The method is the same as in an earlier paper [see Abstract No. 608 (1910)]. The wave-length is determined by the interferometer, a wire grating being used to split up the beam. The lengths of oscillators used are 5, 7·5, 10 cm. In the former paper it was shown that the apparent wave-length of the sender depended on the length of the receiver. It is here found that this is not due to radiation from receiver, nor to the length of spark-gap in sender. Within wide limits the wave-length of the sender is independent of the length of the spark-gap; but with an aperiodic receiver of very high resistance—made of constantan wire 0·0015 cm. diam.—it is found that the apparent wave-length is very nearly independent of the length of the receiver. The wave-length thus measured agrees with that given by Abraham's formula. Mean ratio of wave-length to length of oscillator is 2·05. The log. decrement is of the same order as that given by Abraham's formula. For the same length of spark-gap the total log. decrement decreases as the oscillator length increases. Hard rubber supporting the spark-gap, and kerosene oil in the gap do not sensibly affect the wave-length. The lengths of the auxiliary sparks, within wide limits, do not affect the wave-length. The high-resistance receiver does away with the necessity of tuning. An approximate theory for the high-resistance linear oscillator and the general theory of the interferometer for damped electric waves are given, and it is shown that, when the receiver is not dead-beat, the interferometer curve is the sum of two damped harmonic curves, one having half the wave-length of the sender, the other half the wave-length of the receiver. This is borne out by the experimental results of the earlier paper. T. P. B.

1754. *Hertz Experiments with Electric Waves.* **L. Zehnder.** (Ann. d. Physik, 33. 8. pp. 631–645, and 646–648, Sept. 22, 1910.)—In 1892 the author designed a vacuum tube for a detector of electric waves. A high-potential accumulator battery is just unable to send a discharge through the tube. The tube, however, lights up whenever a discharge takes place across the gap of a Hertz linear receiver—the gap of the receiver being inside the tube. Instead of the accumulator battery the author here uses an induction coil fed with alternating current. A capacity must be connected in parallel with the tube. The voltage at the tube terminals is regulated by resistance in the primary circuit. An interrupter is described for breaking the current through the tube once it has started. The author also describes the high-potential accumulator battery and an attachment for sliding a vacuum tube along the wires of a Lecher-wire system. T. P. B.

1755. *Oscillations from an Arc Burning in Carbon Disulphide Vapour.* **G. Szivessy.** (Jahrbuch d. Drahtlosen Telegraphie, 3. No. 3. pp. 250–283, 1910. Elektrotechnik u. Maschinenbau, 28. p. 278, March 27, 1910. Abstract.)—Exceedingly weak oscillations only are obtained, although the arc burns quietly and evenly. For further details the original pages must be referred to. L. H. W.

1756. *Musical Arc Oscillations in Coupled Circuits.* **E. T. Jones** and **D. E. Roberts.** (Phil. Mag. 20. pp. 660–663, Oct., 1910.)—In a previous paper by Jones and Owen [see Abstract No. 2108 (1909)] photographs were given showing the variation of p.d. between the terminals of the secondary of a pair of coupled circuits when the two oscillations of the system are simultaneously maintained by a musical arc connected with the primary. In these experiments the circuits were so adjusted that the frequency of one of the oscillations corresponded either to one of the harmonics of the other or to the perfect fifth above it. The experiments have been continued and the phenomena in connection with smaller intervals investigated. The smaller ratios were obtained by diminishing the coefficient of coupling of the two coils; and the approximate condition for the equal stability of the two notes is that L_1K_1 must be equal to L_2K_2. It is shown that if the arc be assumed to have a self-inductance rather less than 0·0005 henry and a resistance slightly greater than 4 ohms, the difference of the frequencies of the two oscillations is in perfect agreement with the observed value. The frequencies were computed from the photographic oscillograms. A. R.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1757. *Dielectric Constant of Ice.* **P. Thomas.** (Phys. Rev. 31. pp. 278–290, Sept., 1910.)—The dielectric constant of ice is determined for long waves, frequency = 40 to 80 per sec., and for temperatures from −2° to −18° C. and also for −192° C. Two cylindrical and one plate condenser are used with different distances between the plates. The capacity of the ice condenser is obtained by placing a high resistance in series with it and reading two Dolezalek electrometers connected across the resistance and the condenser. The conductivity of the ice is eliminated by taking readings at two different frequencies. The dielectric constant gradually increases from 93·9 at −2° C. to 96·4 at −8° C. At −192 C. it is 3. This latter result agrees with the observation of Dewar and Fleming. The different condensers give the same results. T. P. B.

1758. *Temperature Coefficients of Electrical Resistance.* **A. A. Somerville.** (Phys. Rev. 31. pp. 261–277, Sept., 1910.)—A continuation of an earlier piece of work [see Abstract No. 1826 (1910)]. The materials tested are Au, Ag, Cu, Fe, Al, Mg, C, manganin, constantan, "advance," "excello," "superior," "ia ia," porcelain, quartz, mica, glass. Oxidation is avoided by filling the furnace with nitrogen. Curves and tables give the temperature-coefficients over the whole range of temperature, 0° to 1000° C. In general cold-drawing increases, while annealing decreases, the resistance. The coefficient in pure metals increases with increasing temperature. The coefficient of iron is almost twice as large as that of most metals, increases rapidly to 785°, the temperature of recalescence, and then falls off rapidly. In the alloys the coefficient varies irregularly with the temperature, but in general falls off for the first 100° C. Constantan gives the smoothest curve. Its total variation in resistance up to 600° C. is less than 1 per cent. "Excello" is a Ni-Cr alloy which does not oxidise in air, does not melt below 1200° C., and is pliable. T. P. B.

1759. *Vacuum Thermo-couple as Radiation Measurer.* **E. S. Johansen.** (Ann. d. Physik, 33. 3. pp. 517–536, Sept. 22, 1910.)—The conditions under which a vacuum thermopile may be rendered most sensitive are discussed mathematically, and it is shown that (1) the heat loss due to conduction through the wires of the junction must be equal to the heat loss due to radiation from the junction; (2) the radii of the thermo-couple wires must be so chosen that the ratio of heat conductivity to electrical resistance in each is the same; for instance, in an Fe-constantan couple, radius of Fe = ½ radius of constantan; in an Fe-Bi couple, radius of Fe = ⅓ radius of Bi. Thermopiles in vacuum are constructed on these principles and tested.

They are compared with a vacuum bolometer. The sensitiveness of both is equal to the product of a constant and the square root of the surface of the junction exposed to the radiation. For an Fe-Bi couple the constant comes out about the same as for the vacuum bolometer. It is indicated as possible that the vacuum thermopile may be used with advantage for measuring the heat radiation of the stars. T. P. B.

ALTERNATING CURRENTS AND MAGNETISM.

1760. *Improved Semicircular Electromagnet.* II. **H. E. J. G. du Bois.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 886–891, Oct. 27, 1910.) —Some more measurements are given in this paper [see Abstract No. 2115 (1909)]. As regards the influence of polar windings, up to ½ or ⅔ saturation the azimuth of the coils on the core remains indifferent. The more, however, the iron becomes saturated, the more does the action of the coils near the air-gap begin to preponderate. "Gradient pole-pieces" were used for investigations in a non-uniform field. The test-piece takes up a position in the equatorial plane such that both the field intensity and the transverse gradient of the intensity are as great as possible, and the attraction or repulsion is measured by the product of these two quantities. A design for oblique-vision pole-pieces is also given which is adapted for special work, *e.g.*, Kerr-effect, and oblique emission effect for spark spectra. G. E. A.

1761. *Hysteresis Loops and Lissajous' Figures.* **S. P. Thompson.** (Phil. Mag. 20. pp. 417–436, Sept., 1910. Paper read before the Physical Soc., July 8, 1910. Electrician, 65. pp. 1058–1062, Oct. 7, 1910. Abstract.)—If we have an impressed voltage of a pure sine-form in the magnetising coil on a closed magnetic circuit, the flux-density curve is also a sine curve and has a lag of 90° behind the voltage curve. The current curve is complex in form but may be constructed graphically if the form of the hysteresis loop is known. The author points out that this current curve can be subjected to harmonic analysis and its harmonic constituents ascertained. Each of these constituent pure-sine curves or cosine curves can be drawn and projected back by a reversal of the graphic process referred to above. The several constituents give separate closed curves and by their summation the original hysteresis loop can be obtained. It thus appears that any hysteresis loop can be analysed into an harmonic series of closed curves corresponding to the various terms in the analysis of the current wave. A mathematical discussion of these constituents follows and shows that any hysteresis loop can be analysed into an harmonic series of Lissajous' figures. Examples are given of the analysis of hysteresis cycles for annealed soft iron, mild steel, and pianoforte steel wire. The relation between the area of a hysteresis loop and the work spent in carrying the iron through a cycle of magnetising operations is next considered. It is shown that the only work done in the cycle is that done by that constituent of the current which is in phase with the voltage, viz., its fundamental sine term. All other constituents are wattless. And since the area of the loop represents the work done, it follows that the area of the hysteresis loop is equal to the area of the orthogonal ellipse which is its fundamental constituent of the sine series. The true and fundamental form of every hysteresis loop is therefore an orthogonally placed ellipse. All departures from that form are wattless—are mere distortions which involve no expenditure of energy. The area W of the hysteresis loop is proportional to the max. value, $B_{max.}$, of the induction B, and to the amplitude H_1 of the first sine-term into which the values of H (corresponding to the values of the current) can be analysed, and is given by $W = \frac{1}{4}\pi B_{max} H_1$. A. D. R.

1762. *The Magnetic Balance of Curie and Chéneveau.* **C. Chéneveau**—with Appendix by **A. C. Jolley.** (Phil. Mag. 20. pp. 857–869, Aug., 1910. Paper read before the Physical Soc., April 22, 1910.)—The apparatus itself has already been described [see Abstract No. 874 (1904)]. In the Appendix a table is given of the results of experiments at the Northampton Institute in which relative determinations were made of the coefficients of specific magnetisation of various substances, distilled water being used as standard substance and Curie's value for the constant measured, viz., $K' = -0{\cdot}79 \times 10^{-6}$, being assumed. From these results it appears that there is a considerable field of usefulness for the balance: (1) For examining the materials to be used for standard apparatus where the permeability is very important; (2) In grading and examining alloys whose properties are materially dependent upon minute traces of alloying constituents difficult to estimate chemically; (3) it might be used to maintain the standard of purity in the commercial production of a metal such as Al, whose chief impurity is iron. [See also Abstract No. 994 (1910).] J. J. S.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

1763. *Water Sterilisation by Ultra-violet Rays.* **V. Henri, A. Helbronner, and M. de Recklinghausen.** (Comptes Rendus, 151. pp. 677–680, Oct. 17, 1910.)—In their first apparatus the authors utilised only one-third of the radiations of the quartz-mercury lamp. The new apparatus consists of a semicircular trough set with 5 radial baffle-plates; the lamp is placed at the centre of the trough, and the water is, in circulating, three times brought up to the lamp. If the lamp should go out the water will escape through a valve without flowing through the trough. The Westinghouse (Cooper Hewitt) lamp for 220 volts and 3 amps. is placed in a rectangular box provided with 3 quartz walls. The apparatus has been run uninterruptedly for 6 weeks, sterilising about 600 m.^{3} of water in 24 hours; more than three-quarters of the radiations are utilised, and the sterilisation is very satisfactory. The current consumption was 26 watt-hours per m.^{3} of water. The water had previously passed through filters of Puech and Chabal and should be transparent; opacity tests were made with a Lovibond tintometer. H. B.

REFERENCES.

1764. *The Accelerated Motion of an Electrified Sphere.* **J. W. Nicholson.** (Phil. Mag. 20. pp. 610–618, Oct., 1910.)—A brief mathematical discussion of the initial motion under a small field of electric force, or a small force of a purely mechanical nature, of a sphere whose charge is initially uniform, and whose mass is purely of electric origin. L. H. W.

1765. *An Experiment concerning the Electrodynamics of Moving Bodies.* **M. Born.** (Deutsch. Phys. Gesell., Verh. 12. 19. p. 780, Oct. 15, 1910.)—Corrections to the author's paper bearing this title [see Abstract No. 1300 (1910)].

1766. *Propagation of Waves of Magnetic Flux along Iron Rods.* **L. Lombardi.** (Accad. Lincei, Mem. 7. pp. 487–531, 1909.)—An amplified account of the research dealt with in Abstract No. 1099 (1909).

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1767. *Preparation of Argon.* **G. Claude.** (Comptes Rendus, 151. pp. 752–758, Oct. 31, 1910.)—Liquid oxygen, prepared by the author's method, contains about 96 per cent. of oxygen and 3 of argon. The gases are passed through a copper tube, charged with reduced copper, to absorb the oxygen at dark-red glow, through an iron tube charged with powdered Mg at red glow, to bind the argon, and a silica tube charged with copper oxide to absorb any hydrogen due to moisture. The copper tube has a length of 60 cm. and a diam. of 6 cm., and contains 2·5 kg. of copper; the iron tube has a length of 40 cm. and a diam. of 8 cm. The apparatus deals with 8 litres of oxygen per min. and yields from 5 to 12 litres of argon in 2 hours; the oxidised copper can be regenerated by means of hydrogen in 1¼ hours. H. B.

1768. *Physical Properties of Radium Emanation.* **R. W. Gray and W. Ramsay.** (Zeitschr. Phys. Chem. 70. pp. 116–127, 1910.)—The paper is practically the same as that dealt with in Abstract No. 1684 (1909). In an appendix the authors describe some anomalous results on the amount of gas produced from the solution of a large quantity of Ra [see Abstract No. 158 (1909)]. The evolution of explosive gas was regular and equal to 25 c.cm. of hydrogen and oxygen per week until Nov., 1909. At that time a piece of apparatus consisting of lead and paraffin was placed near the bulb containing the Ra solution and kept in position until Jan. 18, 1910. During that period the evolution of gas decreased to a very small amount (less than 1 c.cm. per week). Since the apparatus was removed from the vicinity of the bulb the old amount, 25 c.cm. of gas, has been collected per week quite regularly. Thus something inhibited the action of the Ra for a month and a half, and although the authors are quite certain of the facts, they have been entirely unable to reproduce the inhibiting conditions. E. M.

1769. *Separation of Radium D from Radio-lead.* **H. Herchfinkel.** (Le Radium, 7. pp. 198–200, July, 1910.)—The author has tried several methods to separate the RaD from radio-lead, but without success [see also Abstract No. 427 (1908)]. The introduction of various metals into the solution of the chloride of the radio-lead did not lead to any concentration of the RaD, while the crystallisation of the salt was equally unsuccessful. No concentration was arrived at by causing precipitates to form in the solution of the radio-lead, nor was there any decided result of the introduction of animal charcoal. The author also tried to separate the RaD by distillation, but this method was also unsuccessful. E. M.

1770. *Solubility of the Active Deposit of Actinium.* **S. Arrhenius.** (Le Radium, 7. p. 228, Aug., 1910. Paper read before the Congrès Internat. de Radiologie, Brussels, Sept., 1910.)—A strong source of the active deposit from actinium emanation was deposited on a Pt-foil, and this was shaken with water for a known time and dried, when its α-ray activity was found to have decreased far more than that according to the known exponential constants. The amounts of decrease in the common logarithms of the activities for immersions of 5, 10, 80, 120 sec. respectively were 0·087, 0·170, 0·196, 0·295 (after allowing for the ordinary spontaneous decay). Successive washings showed a gradually decreasing amount of solubility, the experiments suggesting that part of the active deposit had diffused into the interior of the Pt-foil. Act A was found to be more soluble than Act B. The presence of acids was found to increase the solubility, while caustic soda gave an increased solubility in strong solution and a decreased solubility in the case of a weak solution. The presence of neutral salts had little effect. Temperature was found to have little influence on the solubility. The author concludes that the active deposit behaves like the oxide of a heavy metal such as zinc or lead. E. M.

1771. *Supposed Change in Weight accompanying Disintegration of Radium.* **B. D. Steele.** (Nature, 84. p. 428, Oct. 6, 1910.)—In a previous paper [Abstract No. 1988 (1909)] the construction of a micro-balance was described, and in the present communication this has been used for the investigation of the change of weight which may acccompany the disintegration of Ra. Two balances of sensitiveness 2·5 × 10^{-9} gm. were mounted side by side in such a way that one served as a check on the other. One of the balances was provided with a piece of Pt-wire which could be charged to a negative potential of 500 volts. By means of a circulating apparatus the air in the balance case could be bubbled continuously through a solution of 7·5 mgm. of $RaBr_2$, thus keeping it charged with RaEm. The RaA produced from the RaEm should therefore be driven on to the charged and counterpoised Pt-wire and accumulated there, and its weight determined. The increase of weight found was 80 × 10^{-7} gm. per day, instead of 10 × 10^{-9} as expected from a theoretical calculation. This discrepancy may be due to the vapour of the grease in the joints becoming condensed on the ions formed by the RaEm, and thus being carried by the electric field to the Pt-wire; but further experiments are being made in which this effect, if it exists, will be eliminated. E. M.

1772. *Decomposition of Ozone by Ultra-violet Rays.* **Eva v. Bahr.** (Ann. d. Physik, 33. 3. pp. 598–606, Sept. 22, 1910.)—Since the absorption of infra-red rays by ozone increases with increased pressure, a similar increase might be expected for ultra-violet rays, such as R. W. Wood observed in mercury vapour. The spectrum of a quartz mercury lamp is formed with the aid of quartz prisms and lenses, and the intensity of the ultra-violet determined from the rate of discharge of a narrow strip of Pt charged to 216 volts, this arrangement being due to S. Werner. An absorption tube filled with ozonised oxygen is interposed in the path of the rays. The ultra-violet rays have a strong de-ozonising effect, which may account for the fact that Hallwachs [see Abstract No. 760 (1910)] obtained too little ozone. The de-ozonisation becomes more marked as the pressure is lowered, and is especially noticeable below 100 mm.; it seems to be due to rays of wave-length ranging from 230 to 290 $\mu\mu$; according to E. Meyer ozone has a strong absorption band at 257 $\mu\mu$. The question of the absorption of the rays remains open. H. B.

1773. *The Conversion of Diamond into Graphite.* **R. Vogel** and **G. Tammann.** (Zeitschr. Phys. Chem. 69. pp. 598–602, 1909.)—The change of a crystal into another, more stable modification proceeds at a more rapid rate and starts from more points within the units of volume and time as the temperature increases; the longer a crystal is heated, the lower the temperature at which the conversion becomes perceptible. Thus there is, according to the authors, no sharp lower temperature limit for such conversions. Bort became fused and graphitised in an electric tubular carbon furnace in 5 min. at 1880° C. (Wanner pyrometer). Diamond splinters, 2 mm. in diam., only turned superficially grey in 5 min. at 1890° in similar furnaces. Other experiments were made with the diamonds embedded in CaO and SiO_2 at 1600°. Heated for 24 hours in a closed porcelain tube a diamond became covered with grey patterns, triangles and truncated triangles; in 48 hours only graphitic grains remained. In a small quartz tube one diamond remained unchanged for 48 and even 96 hours at 1000°; another turned superficially black in 24 hours. H. B.

1774. *Ductile Tungsten and Molybdenum.* **C. G. Fink.** (Amer. Electrochem. Soc., Trans. 17. pp. 229–233; Discussion, pp. 233–234, 1910. Metallurgical and Chem. Engin. 8. pp. 340–341, June, 1910.)—The author gives a few more particulars as to the physical properties of ductile tungsten and some relating to ductile molybdenum [see Abstract No. 615B (1910)] but no information as to the method of preparation of the metals. Ductile tungsten is a bright, tough, steel-coloured metal, which can be drawn into the finest wire, much below 0·001 in. The tensile strength of the wire increases as the drawing proceeds; or in other words, the more the metal is mechanically worked, the tougher and stronger it gets. The tensile strength of tungsten wire ranges from 460,000–490,000 lbs. per sq. in. for wire of 0·125 mm. diam., up to 580,000–610,000 lbs. per sq. in. (406–427 kg./mm.^{2}) for a wire of 0·030 mm. diam. For Mo wire the tensile strength is 200,000–260,000 lbs. per sq. in. for a 0·125 mm. diam. wire, and 270,000–310,000 lbs. per sq. in. (189–217 kg./mm.^{2}) for wire of 0·088 mm. diam. The density values of both W and Mo increase with the amount of working. In the case of W, which showed sp. gr. 18·81 before drawing, the sp. gr. reached 19·3 on drawing down to 3·75 mm., and went up to 19·86–20·19 when drawn down to 0·088 mm. diam. Molybdenum in the same way showed a rise of sp. gr. from 10·02 for the metal before drawing, to 10·04 and 10·32 when drawn down to wires of the respective diameters mentioned above. For tungsten the resistivity, at 25°, in microhms per cm. cube is found to be 6·2 and 5·0 for the hard-drawn and the annealed wire respectively, and the temperature-coefficient, between 0° and 170° C., 0·0051. For Mo these values are 5·6 and 4·1 respectively for the resistivity, and 0·0050 for the temperature-coefficient. The values obtained for the thermal expansion coefficients are 336 × 10^{-8} for tungsten and 360 × 10^{-8} for molybdenum, the temperature range being 20–100°. Chemically, the two ductile metals behave similarly in many respects. The drawn wire retains its lustre almost indefinitely. Both metals are readily attacked by fused oxidising salts, such as $NaNO_3$, $KHSO_4$, and Na_2O_2. Acids (HCl, HNO_3, H_2SO_4) attack W very slowly, but Mo rather readily. L. H. W.

1775. *Determinations of the Constants of Materials for Furnace Electrodes.* **C. Hering.** (Amer. Electrochem. Soc., Trans. 17. pp. 151–170, 1910.)—Full details are given of the method of determining electrode constants which, briefly described, consists in embedding a rod of the material to be tested in a heat-insulating material, allowing the two ends to project sufficiently for terminals. A steady current is then passed through to heat it, and the temperatures at the middle and the ends, the voltage at the two ends, and the current, are then measured. From these data all the necessary physical constants are calculated. The paper includes full details of materials used, connections and couplings, temperature measurements, current and voltage measurements, method of protecting test-bars from oxidising gases, &c. A table is given of the observed data for electrodes of carbon, graphite, iron, and copper, but no attempt is made in this paper to discuss the results. [See Abstracts Nos. 1021, 1023 (1910).] C. O. B.

1776. *Empirical Laws of Furnace Electrodes.* **C. Hering.** (Amer. Electrochem. Soc., Trans. 17. pp. 171–198; Discussion, pp. 199–222, 1910.)—The experimental results of the determination of the physical constants of electrodes [see preceding Abstract] are analysed with a view of finding out whether any of the physical properties involved follow some approximate general laws. It is shown that it is possible to find empirical laws for the values of the two simple and determining factors E and S′; E, measured in volts, representing the specific loss in watts for any particular range of temperature, that is, the loss per ampere. Although correctly measured in volts, its real significance is better represented by the term "watts per ampere." S′ is the specific section, measured in units of area for any particular range of temperature, that is, the cross-section required per ampere per inch of length in order that there shall be no flow of heat either way through the furnace end. The two quantities together are all that is required for calculating an electrode. For further details, the paper, which is unsuitable for a brief Abstract, should be referred to. [See also Abstract No. 465 (1910).] C. O. B.

1777. *Hardness of Alloys of Nickel and Copper with Electrolytic Iron.* **G. A. Roush.** (Metallurgical and Chem. Engin. 8. pp. 468–470, Aug., and pp. 522–523, Sept., 1910.)—This investigation is a part of an extensive research on these alloys which is being carried out at the University of Wisconsin [see Abstracts Nos. 446 and 616 (1910)]. Alloys containing up to 45 per cent. Ni and 8·5 per cent. Cu were prepared and tested, by means of the scleroscope, in the forged condition and after annealing at 900° C. In the forged condition the hardness reaches a maximum at 11 per cent. Ni, then falls slowly to 19 per cent., then rapidly to 25 per cent., after which it remains almost constant. After annealing, the maximum occurs at 16 per cent., then comes a sharp decline to 32 per cent., after which the hardness is constant at a value very little above that of pure iron. In the unannealed Cu alloys the hardness increases slowly but somewhat irregularly with no well-defined maximum, while in the annealed state the hardness increases slowly along a straight line. Comparison with the electrical resistance curves [Abstract No. 446 (1910)] shows that in the Ni-Fe series (a continuous series of solid solutions) the max. hardness occurs at 10 to 20 per cent. Ni, while the max. resistance occurs at 30 per cent. Ni. This is contrary to the views of Kurnakow and Żemčzuzny [Abstract No. 2140 (1909)], to the effect that in a series of solid solutions the maximum of hardness should coincide with the maximum of electrical resistance, and the author concludes that the Ni-Fe and Cu-Fe series are exceptions to this rule. In the second article the author extends his work to the case of ternary alloys of Cu, Ni, and electrolytic iron, prepared by adding from 2 to 20 per cent. Monel metal. In forged alloys the hardness rises rapidly up to 10 per cent. Monel metal, and then more gradually, while in the annealed samples the increase is not so rapid. The max. hardness is reached at about 12 per cent. as against 16 per cent. in the case of pure Ni, the actual values being about the same. F. C. A. H. L.

1778. *Hardness of Lead-Tin Alloys.* **D. Stenquist.** (Zeitschr. Phys. Chem. 70. pp. 586–588, 1910.)—Describes a method of applying the Brinell hardness test to lead-tin alloys, and gives results obtained. The hardness of lead alloyed with tin rises at first rapidly with the proportion of tin; an alloy containing 7 per cent. having the same hardness of pure tin. An alloy of 50 to 55 per cent. tin has the greatest hardness, after which the hardness decreases with increase of tin. C. O. B.

1779. *Solutions of Gases in Metals.* **A. Sieverts.** (Zeitschr. Elektrochem. 16. pp. 707–712; Discussion, pp. 712–718, Sept. 1, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)—The author has studied the occlusion of gases by metals, and describes the general results without experimental details [see Abstract No. 2116 (1907)]. The experiments included the study of (1) the influence of temperature at constant gas pressure (atmospheric), (2) the diffusion of gases through metals, (3) the relations between solubility and the metal surfaces, (4) the solubility of gases in binary alloys, and (5) the relations between solubility and gas pressure, well-characterised compounds such as hydrides, nitrides, and oxides being omitted from the experiments. Cadmium, Tl, Zn, Sb, Bi, Sn, Sb, Al, Ag, and Au dissolve neither nitrogen nor hydrogen; nitrogen is insoluble in Cu, Ni, and Pd, and forms a nitride with Al above 800° C. Copper does not occlude CO or CO_2, but in the molten state decomposes hydrocarbons, with deposition of graphite carbon. Hydrogen shows the most general solubility, which was determined quantitatively in the cases of Pd, Fe, Ni, Co, and Cu. Oxygen forms solutions of the *-ous* oxides with most metals, but its solubility in silver was determined. Nitrogen is absorbed only in a few special cases. Powdered iron reduced from an oxide absorbs nitrogen suddenly at about 900° C., the amount absorbed being given off again on cooling. It appears, therefore, that one of the modifications of iron (probably γ-iron) dissolves nitrogen at high temperatures. Technically pure and electrolytic iron absorb nitrogen slowly and do not evolve the gas on reheating *in vacuo*, which points to the formation of nitrides. The solubility of SO_2 in Cu, well known in metallurgical practice, has also been studied. In most systems the solubility increases regularly with the temperature, and the absorption must be regarded as endothermic. At the melting-point of the metal an abrupt increase of solubility occurs, after which it again increases along a straight line. In the case of Pd and hydrogen the solubility falls suddenly at the melting-point of the metal. Silver absorbs very little oxygen while solid, but at the melting-point the solubility increases suddenly and then slowly falls again as the temperature rises. Gases which are capable of forming solid solutions with metals must possess the property of diffusing through the metals, and in nearly all cases this has proved to be the case. The velocity of diffusion increases rapidly with the temperature, and depends largely on the state of the metal surface. Palladium black dried at 100° C. absorbs gases more rapidly than the ignited black, which in turn absorbs gases quicker than Pd-wire does, but since the solubility does not depend upon the actual state of the metal in a case of pure solution, the above phenomenon is one of adsorption. It is well known that the noble metals precipitated as "blacks" contain large quantities of oxygen, hydrogen, CO_2, and moisture, which are given up on heating and not reabsorbed on cooling, and there is no definite evidence of the state in which these gases exist in the metals. The solubility of oxygen in molten Au-Ag alloys decreases, while that of hydrogen in molten Cu alloys increases with the temperature. The effect of composition on the solubility of hydrogen has been studied in the case of Cu alloys, and it has been shown that while Ag does not affect the solubility, Ni and Pt give rise to a considerable increase. Metals forming compounds with Cu decrease the solubility, and there is always a discontinuity in the curve at a concentration corresponding to the compound. The compounds Cu_3Al and Cu_3Sn have been found to dissolve hydrogen. In the majority of the systems studied the relation between solubility and pressure is summed up in the equation $m = kp^{\frac{1}{2}}$, where p is the gas pressure and m the amount absorbed.

F. C. A. H. L.

1780. *Sulphurous Acid as a Metallographic Etching Medium.* **S. Hilpert** and **E. Colver-Glauert.** (Zeitschr. Anorg. Chem. 68. 1. pp. 63–68, Aug. 25, 1910.)—The development of structure is generally effected by the solvent action of an etching medium, and the presence of finely divided constituents is often hidden by the surrounding constituents. The authors have endeavoured to find a medium which will colour the constituents of steel by purely chemical means without exerting an undue solvent effect on the foreground. Heat tinting, largely used in this connection, cannot be applied to hardened and tempered steels. After numerous experiments the use of commercial sulphurous acid diluted with 25 vols. of water or alcohol was adopted. This colours the constituents at different rates; the mechanism of the reaction appears to be a partial solution of the iron as ferrous thiosulphate and sulphite, while a layer of iron sulphide is formed on the etched portions of the specimen; etching is complete in 5–10 sec. Since ferrite is attacked at almost the same rate as pearlite, the medium is not useful for low-carbon steels, for which picric and nitric acids are quite adequate. Sulphurous acid is specially useful in detecting the presence of cementite (not attacked) in hardened steels, and develops the martensitic structure very well. Another application is in the study of basic irons containing phosphide eutectic and irons containing manganese sulphide, the results being quite equal to those obtained by heat tinting. F. C. A. H. L.

1781. *Alloys of Electrolytic Iron and Monel Metal.* **C. F. Burgess** and **J. Aston.** (Metallurgical and Chem. Engin. 8. pp. 452–456, Aug., 1910. Eng. News, 64. pp. 256–257, Sept. 8, 1910.)—An extensive series of tests has been carried out on alloys of Cu, Ni, and Monel metal with electrolytic iron, the purity of which entirely eliminates doubts as to the probable effect of impurities. *Fe-Ni Alloys.*—The first effect of Ni is to increase both tenacity and ductility; afterwards a sudden increase in strength with corresponding decrease in ductility arises over a brittle zone, the exact position of which depends largely on the C and Mn-contents. In a pure alloy the area lies between 10 and 16 per cent. Ni, while with 0·82 per cent. C. and 1·0 per cent. Mn the zone is lowered to 7, or even 5 per cent. Further addition of Ni restores the ductility, while annealing the alloys confines the brittle zone to much narrower limits. *Fe-Cu Alloys.*—The results are in general disagreement with the accepted opinion as to the deleterious influence of Cu, which appears to be due to the combined effects of Cu, carbon, and sulphur. In the absence of the latter elements, addition of Cu up to 7 per cent. (the limit of forgeability) results in an increase of tenacity with a decrease of ductility. Annealing lowers the tenacity and increases the ductility, the properties of an alloy containing 1¼ per cent. Cu approaching those of an alloy with a similar content of Ni. Preliminary experiments on the ternary alloys up to a combined content of 8 per cent., in the proportion of 2Ni to

1Cu, were sufficiently encouraging to warrant a further investigation, using Monel metal as the alloying agent. Monel metal is lower in price than Ni, its composition being somewhat as follows: Ni, 66·90 to 67·96 per cent.; Cu, 24·35 to 26·00; Fe, 5·00 to 2·80; Mn, 2·18 to 1·62 per cent. It possesses very good inherent mechanical properties; in the form of rolled bars its elastic limit lies between 74,400 and 79,000 lbs., and its ultimate stress between 100,000 and 104,000 lbs. per sq. in. The alloys were prepared by melting electrolytically-refined Swedish iron of 99·97 per cent. purity with the predetermined quantity of Monel metal in electrically-heated, magnesia-lined, graphite crucibles. Ingots containing up to 20 per cent. Monel metal were prepared, forged into bars, and then tested in the "forged" and annealed conditions. The 2 to 12 per cent. alloys forged readily, those containing 12 to 18 per cent. Monel metal forged well at a bright red, while the 18 to 20 per cent. alloys required a white scintillating heat for forging. The alloys above 12 per cent. were too hard for machining, consequently the test-pieces had to be prepared by grinding. In the unannealed state the addition of Monel metal produces a rapid increase in the elastic limit and ultimate stress. Up to 4 per cent. the ductility is increased, and an alloy of this content shows a yield-point of 61,070 lbs., an ultimate stress of 81,000 lbs. per sq. in., with an elongation of 30 per cent. The 18 per cent. alloy, which shows the max. value for ultimate stress, shows the remarkable figures of yield-point 172,000, ultimate stress 215,000 lbs. per sq. in., with an elongation of 10 per cent. The general effect of annealing appears to be, especially within the useful range (4 to 8 per cent.), to increase the tenacity without seriously affecting the ductility. Comparing the properties of the ternary with those of the binary alloys, it will be noticed that the further addition of Monel metal does not result in the recovery of the ductility which is observed in the Ni series. There is no doubt that the ternary alloys compare very well with the binary alloys throughout the series. A comparison of the annealed 4 per cent. Ni and Monel metal alloys shows the figures:—

	4 per cent. Monel Metal.	4 per cent. Nickel.
Yield-point..........................	71,800 lbs. per sq. in.	52,100 lbs. per sq. in.
Max. stress..........................	87,800 „	70,070 „
Elongation, per cent.	23·7 „	28·4 „
Reduction, in area, per cent.....	60·4 „	66·7 „

The problem as to whether the same beneficial effects will be exerted on commercial steels by the combined presence of Ni and Cu is now under consideration. F. C. A. H. L.

1782. *Solubility of Oxygen in Molten Silver.* **F. G. Donnan** and **T. W. A. Shaw.** (Soc. Chem. Ind., Journ. 29. pp. 987–989; Discussion, p. 989, Aug. 31, 1910.)—Describes an apparatus and method of determining the solubility of oxygen in silver at various pressures. Details of only two determinations are given, as Sieverts and Hagenacker published results on the same problem [Abstract No. 721 (1909)] after the first experiments had been made. The volume of oxygen absorbed by 10 gm. of melted silver at 1020° C. and 751 mm. pressure was found to be 20·5 c.cm.; the second determination, at 1020° C. and 758 mm., gave 20·2 c.cm. These figures agree well with Sieverts' which are given and which show that the concentration of the oxygen in molten silver is proportional to the square root of the oxygen pressure over a wide range of pressures. From this it is concluded that the oxygen is either physically dissolved as atomic oxygen, or exists in the form of dissolved silver monoxide. C. O. B.

1783. *Vapour-pressure of Water and Aqueous Solutions of Sodium Chloride, Potassium Chloride, and Sugar.* **F. C. Krauskopf.** (Journ. Phys. Chem. 14. pp. 489–508, June, 1910.)—The author's values for the vapour pressure of water are shown in comparison with those of other observers in the following table :—

Temperature.	Results of—					
	Regnault.	Tables of Landolt and Börnstein.	Perman.	Holborn and Henning.	Lincoln and Klein.	Krauskopf.
25°	23·55	23·55	—	23·69	23·76	23·71
30	31·55	31·55	31·88	31·71	—	31·84
35	41·83	41·85	—	42·02	—	41·91
40	54·91	54·97	—	55·18	—	55·18
50	91·88	92·17	92·39	92·30	—	92·16
60	148·78	149·21	148·94	149·19	—	149·26
70	233·09	233·79	233·98	233·58	—	233·99
80	354·64	355·47	—	355·10	—	355·08

The vapour tensions of aqueous sodium chloride solutions were also determined for four different concentrations and at temperatures of 40° and 60° ; also for potassium chloride solutions at five different concentrations and at 40° C. The molecular weights calculated from these results increase with decrease in concentration in accord with those obtained by boiling- and freezing-point methods and opposite to what would be expected according to the Arrhenius theory of electrolytic dissociation. The vapour pressures of sugar solutions were determined for three concentrations at 40° C. The molecular weights found decrease with decrease in concentration. In all cases the molecular weights calculated from the diminution of the vapour pressure differ greatly from the theoretical. T. M. L.

1784. *Interdependence of the Physical Properties of Solutions.* II. *Surface-tension and Electrical Conductivity of Aqueous Salt-solutions.* **A. Heydweiller.** (Ann. d. Physik, 33. 1. pp. 145–185, Aug. 5, 1910.)—Measurements, taken largely from the Dissertations of the author's students, are given of the surface tensions of aqueous solutions of 29 salts over wide ranges of concentrations ; in addition to the usual method of measuring the capillary height, measurements were made by means of drop-weights, of bubble-pressures, and of air-bubbles. In all cases the quantity worked out was the percentage molecular alteration of surface tension (as compared with water), calculated from the formula, $\Delta_a = 100(\alpha - \alpha_0)/m\alpha_0$, α_0 being the value for water, and α that for the solution. This quantity is not independent of the concentration, as has usually been supposed, but passes through a pronounced minimum value as the concentration is decreased and the ionisation increases. The curves can be represented by the equation, $\Delta_a = B_a + (A_a - B_a)i + C_a m$, the effects produced by the salt being influenced additively by the ionised and the un-ionised parts. The constant A_a, which represents the influence of the ionised part, is always positive, and varies only within narrow limits (2 to 8 per cent. per gm.-equivalent). As salts of similar type produce almost identical effects, it is suggested that these are due to the electrical interaction of the oppositely-charged ions ; in confirmation of this view it is pointed out that salts composed of two univalent and one divalent ions give figures 1·5 times as great as those for two univalent ions, whilst salts composed of two divalent ions give figures twice as great. The influence of the undissociated molecules is smaller and variable in sign (+0·1 to −3 per cent. per gm.-equivalent). The cohesion of the dissolved substance itself, C_a, is of very small importance, amounting only to 0·07 to 0·6 per cent. for normal concentration. T. M. L.

1785. *Vapour-pressures, Specific Volumes, Heats of Vaporisation and Critical Constants of Thirty Pure Substances.* **S. Young.** (Roy. Dublin Soc., Proc. 12. 31. pp. 374–448, June, 1910.)—The substances investigated were: Normal pentane, hexane, heptane and octane. Isopentane, di-isopropyl, di-isobutyl. Hexamethylene. Benzene, fluoro-, chloro-, bromo-, and iodo-benzene. Carbon tetrachloride. Stannic chloride. Ether. Methyl alcohol, formate, acetate, propionate, butyrate and isobutyrate. Ethyl alcohol, formate, acetate and propionate. Propyl alcohol, formate, and acetate. Acetic acid. The properties recorded are: Vapour-pressures, observed and calculated from 0° to the critical temperature, with the numerical constants of Biot's formula $p = a + b\alpha^t + c\beta^t$. Heat of vaporisation from 0° to the critical temperature. Volume of 1 gm. and density of liquid and saturated vapour from 0° to the critical temperature, with the numerical constants in the modified formula of Cailletet and Mathias, $s_t - s_0 + at + \beta t^n [+ \gamma t^n]$, the last term being used only in the case of the three alcohols. Values are given for every 10° over the whole range, and for intervals of about 0·5° in the neighbourhood of the critical temperature. The *molecular* volumes, &c., have been omitted owing to trouble arising from changes made from time to time in the accepted values for the atomic weights. T. M. L.

1786. *Volume Contraction, Density Maxima, and Internal Pressure of Mixtures of Ethyl Alcohol and Water.* **O. Tumlirz.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 393–417, March, 1910.)—The original should be referred to for the tables and curves of results. It is noteworthy that a mixture of 100 gm. water and 4·775 gm. ethyl alcohol has a max. density at the same temperature (3·972° C.) as for pure water. The density maximum of a mixture of water and ethyl alcohol lies at a higher or a lower temperature than for the case of pure water, according as, at temperature 3·972° C., the product 0·0012817x is less than or greater than dK/dt; here x is the mixture ratio, and dK/dt the change of contraction with the temperature. The fact that the contraction increases very markedly with increase of temperature explains the observation that the max. density temperature of water is raised by the addition of a little alcohol, which has hitherto appeared inexplicable. L. H. W.

1787. *Properties of Salt Solutions in Relation to the Ionic Theory.* I. *Mol-numbers derived from the Freezing-point Lowering.* **A. A. Noyes** and **K. G. Falk.** (Amer. Chem. Soc., Journ. 32. pp. 1011–1030, Sept., 1910. Contribution from the Research Lab. of the Mass. Inst. of Technology, No. 56.)—The authors have carried out the very valuable work of collecting all the available data for the freezing-points of salt solutions at concentrations from 0·005 to 0·5 equivalents per 1000 gm. of water. A value has been attached to the different figures according to their probable accuracy, and a weighted mean has been given for a series of concentrations for 42 different salts. The mol-numbers deduced from the freezing-points are based upon the formula of Washburn (Technology Quarterly, 21. p. 878, 1908) which in the case of water as solvent has the form $iN = (\Delta t/1{\cdot}858)(1 + 0{\cdot}0055\Delta t)$, where N represents the actual number of formula-weights of solute per 1000 gm. of water, iN represents the number of gm.-mols. of solute per 1000 gm. of water as deduced from the freezing-points, and the ratio or correcting factor i (as used by van't Hoff in interpreting the osmotic properties of electrolytes) is the "mol-number" tabulated by the authors. For 7 di-ionic salts (chlorides and bromides) of the type MX the mol-numbers are fairly uniform, the mean values being as follows:—

Concentration......	0·005	0·01	0·02	0·05	0·1	0·2	0·5
Mol-number	1·952	1·937	1·925	1·887	1·864	1·837	1·804

In this series the sodium salts give slightly higher values than the potassium salts, and exceptionally high values are given by LiCl and NaBr at concentrations above 0·2; data for the iodides are not given. The oxygenated di-ionic salts of the formula MXO_3 (nitrates, chlorates, bromates, and iodates) form a second group, but the individual mol-numbers vary more widely than in the case of the preceding group; thus the values for concentration 0·1 are:—

	Cl.	ClO_3.	BrO_3.	IO_3.	NO_3.
Na	1·875	1·860	1·844	1·778	1·880
K....................	1·861	1·798	1·805	1·765	1·781

But at concentration 0·01 the values are much closer together, ranging only from 1·901 for KNO_3 to 1·928 for $KBrO_3$ in the case of 7 salts. Fourteen tri-ionic salts of the types MCl_2, $M(NO_3)_2$, and M_2SO_4 form a third group in which the i-factor rises to 2·918 in the case of $ZnCl_2$ at concentration 0·005, whilst values below 2 are found only in the case of the cadmium salts (especially the iodide, which probably ionises in part without raising the mol-number, according to the scheme $2CdI_2 \rightleftarrows Cd + CdI_4$, and gives exceptionally low values), and in the case of lead nitrate at the two highest concentrations 0·4 and 0·5. The five sulphates of divalent metals, MSO_4, form a natural group, but the i-factors, although fairly uniform, are much lower than in the case of the di-ionic salts of the formula MX, the values at concentration 0·005 ranging from 1·658 for $CdSO_4$ to 1·788 for $NiSO_4$ as contrasted with a range from 1·944 for LiCl to 1·963 for KCl. The change of the mol-number with concentration may be expressed satisfactorily by the formula $2 - i = KC^{1/3}$ for di-ionic salts; $3 - i = 2KC^{1/3}$ for tri-ionic salts. Agreement with the formula is almost perfect up to 0·1N for the salts MCl and MBr ($K = 0{\cdot}292$); the chlorates and bromates agree within 0·5 per cent., taking $K = 0{\cdot}384$ for $NaClO_3$ and $NaBrO_3$, $K = 0{\cdot}418$ for $KClO_3$ and $KBrO_3$; the iodates and the tri-ionic salts show differences amounting to about 1 per cent. or a little over, taking $K = 0{\cdot}45$ for KIO_3 and $NaIO_3$, $K = 1{\cdot}10$ for Na_2SO_4, $K = 1{\cdot}00$ for $BaCl_2$, and $K = 1{\cdot}47$ for $Pb(NO_3)_2$. The di-ionic salts of the second type, viz., $MgSO_4$ and $CuSO_4$, cannot be made to fit in at all with this formula. The authors propose to extend their work to other properties of aqueous salt-solutions, and their method of investigation promises to lead to results of very great value. T. M. L.

1788. *Solubility and Physical State of Solvent in Absorption of Carbon Dioxide by p-Azoxyphenetole.* **I. F. Homfray.** (Chem. Soc., Journ. 97. pp. 1669–1676, Aug., 1910.)—p-Azoxyphenetole does not absorb CO_2 when in the solid crystalline form between 0° and 139°. The liquid crystals between

139° and 166° absorb the gas freely, *e.g.*, 29·6 c.cm. per 100 c.cm. at 145·5°. The solubility in the isotropic liquid is greater, viz., 42·8 c.cm. per 100 c.cm. at 166·5°. The increase of solubility of the gas with rising temperature can only be attributed to the influence of the physical state of the solvent. T. M. L.

1789. *Conductivity and Dissociation of Organic Acids in Aqueous Solution at Different Temperatures.* **G. F. White** and **H. C. Jones.** (Amer. Chem. Journ. 44. pp. 159–199, Aug., 1910.)—The temperature coefficients of conductivity for the organic acids are small and of the same order of magnitude: they decrease with rise of temperature and with dilution. In the case of the amino-acids the coefficients are exceptionally large and increase with rise of temperature: this is attributed to their amphoteric character leading to internal salt-formation in solution. In the former case a parabolic formula can be used to express the relationship between temperature and conductivity over the narrow range from 0 to 88°; in the case of the amino-acids the parabolic formula cannot always be used. The coefficients of ionisation sometimes decrease regularly from 0° upwards; in other cases maxima appear to be indicated in the values for μ_v/μ_{2048}, the latter being taken as equivalent to infinite dilution. Isomeric acids are not equally dissociated, but give rise to ions of equal mobility. It is proposed to deal with the range from 35° to 65° in a separate paper. T. M. L.

1790. *Electrochemical Investigation of Liquid Amalgams of Thallium, Indium, and Tin.* I. **T. W. Richards** and **J. H. Wilson.** (Zeitschr. Phys. Chem. 72. 2. pp. 129–164, 1910. From the English.)—The potentials between various liquid amalgams of Tl, In, and Sn at 30° and 0° were measured, and the numbers obtained are regarded as accurate within 0·00001 volt in the case of Tl amalgams, and within 0·000005 volt in the case of the In and Sn cells. It was found that Tl and In amalgams give higher potentials than those calculated from the simple concentration law, whereas the Sn amalgams give lower potentials. The temperature-coefficient of the various cells were found to approach to the limiting value 0·00866, on approach to the condition of infinite dilution. The authors applied the equation of Cady, $\pi = U/\nu F + RT/\nu F \log_e C_m/C_n$, and found that it gave a fairly exact explanation of the deviations from the concentration law (the equation takes into account the heat of dilution). As regards the changes of the temperature coefficients, it was found that Helmholtz's equation enables one satisfactorily to calculate these. The authors found the density of In to be 7·28, and they also determined the densities of the amalgams. A. F.

1791. *Electrochemical Investigation of Liquid Amalgams of Zinc, Cadmium, Lead, Copper, and Lithium.* II. **T. W. Richards** and **R. N. Garrod-Thomas.** (Zeitschr. Phys. Chem. 72. 2. pp. 165–201, 1910. From the English.)—In the case of cells formed with the above amalgams, it was found that in every case the more concentrated amalgams gave values which were considerably different from those calculated according to the concentration law—in some cases the value was higher and in other cases lower than the calculated. Three-fourths of this deviation is explicable by Cady's formula, and the other fourth must be ascribed either to experimental errors or, more probably, to the inaccuracy of the concentrative law, *e.g.*, owing to the formation of compounds or to polymerisation. The formula of Cady is not very suitable for the purpose of calculating heat of dilution, as all errors and deviations accumulate in the smallest member of the equation. From the Helmholtz equation it is found that the heat of dilution very rapidly decreases with increased dilution. The solubility of copper in mercury was found to be 0·0024 per cent., and of iron 0·00184 per cent. by weight. It was further found that all deviations from the simple concentration law diminished with increasing dilution, so that at a concentration of 0·01 gm.-atom per litre all the amalgams behaved practically as ideal solutions. [See also preceding Abstract.] A. F.

1792. *Electromotive Behaviour of Oxygen.* **F. Foerster.** (Zeitschr. Phys. Chem. 69. pp. 236–271, 1909.)—[See Abstracts Nos. 910 and 1187 (1905), 1489 and 1885 (1906), 1188 (1909).] The electrolytic behaviour of oxygen was investigated, and for this purpose the behaviour of nickel peroxide and platinised Pt electrodes was observed. The measurements were made in both acid and alkaline solutions. The chief results obtained were: (1) A platinised Pt electrode, polarised with oxygen and left in dilute sulphuric acid through which oxygen is passed, showed a gradually sinking value, reaching at last the oxygen potential of +1·09–1·08 volts measured against hydrogen in the same electrolyte. (2) An Ir electrode covered with iridium black showed a much more rapid fall of potential, which did not cease to sink at 1·06 volts, but sank to +0·86 volt in 2*n*. H_2SO_4. (3) The explanation given of this is that in all probability a labile platinum and iridium oxide is formed, analogous to nickel oxide, and these form, with the finely divided metal a homogeneous phase like a solution. These oxides PtO_x and IrO_y decompose and lose part of their oxygen and leave behind the stabler oxide. The gradual sinking of the potential denotes the gradual decomposition of the oxide. F. J. B.

1793. *Cells of Antimony and Antimony Selenide.* **H. Pélabon.** (Comptes Rendus, 151. pp. 641–644, Oct. 10, 1910.)—The author has studied the effect of light on the cell formed by placing rods of pure Sb and an alloy of Sb and Se in a hydrochloric acid solution of $SbCl_3$. The e.m.f. of such a cell, on open circuit, when kept in the dark, acquires a constant value after some days, provided the temperature does not vary; but if light is suddenly thrown upon the anode, the e.m.f. immediately rises, and then, if the illumination is continued, begins to decrease until after about 20 min., it has regained its former value, at which it remains so long as the light is maintained. If now the cell is again placed in darkness, the e.m.f. at first decreases, and then, in continued darkness, gradually regains its original figure. An e.m.f. of 0·0559 volt in the dark rose to 0·0789 volt when first exposed to light, and, on again removing the light, fell to 0·0359 volt, the variation in each case being about half the original value. In a closed circuit the effect of light is even greater, an e.m.f. of 0·0135 volt in the dark rising to 0·0780 volt when the anode was subjected to the light of a Nernst lamp, and subsequently falling on removal of the light to 0·0024 volt. Similar phenomena are observed whatever the proportion of Se in the anode, alloys very weak in Se producing the most sensitive cells. Cells in which the Se is replaced by sulphur or Te are no longer sensible to light. The effect is not produced by ultraviolet rays, and only feebly by blue rays; yellow and red rays are the most active. W. H. Si.

1794. *Thermodynamics of Weston Normal Cell.* **E. Cohen and H. R. Kruyt.** (Zeitschr. Phys. Chem. 72. 1. pp. 84–92, 1910.)—The calculation of the chemical energy of the Weston cell, as given by Hulett [see Abstract

No. 1814 (1909)], is carefully considered. It is shown that it is not possible to give a correct temperature-e.m.f. formula for the cell if such is based on measurements previously made for this purpose. This is owing to insufficient attention having been paid to the behaviour of cadmium amalgams. It is pointed out that it is possible to give a strictly valid temperature-e.m.f. formula between —4° and +40° C. by using a cadmium amalgam containing 8 per cent. by weight of Cd. F. E. S.

1795. *Conduction of Electricity through Glass.* **M. Le Blanc and F. Kerschbaum.** (Zeitschr. Phys. Chem. 72. 4. pp. 468–507, 1910.)—Electrolysis of sodium glass changes it into a badly conducting substance which possesses different properties from the original glass. In the apparatus used mercury served as the electrodes, being in contact on both sides with the glass plate to be investigated. A badly conducting layer is formed on the anodic side of the glass plate and sodium is deposited at the kathode in a quantity corresponding to the current strength. The conduction of electricity through the badly conducting layer is not connected with the transport of ponderable material, and in this layer Ohm's law does not hold, since the current strength varies with the square of the voltage; that is, the relation between these two variables is a parabolic one. During the formation of the anode layer at 320° only sodium is deposited; the silicate ions give up their charge without undergoing decomposition. If a 1 per cent. Na amalgam is used instead of the original mercury kathode and the current reversed, sodium ions are again introduced into the electrolysed mass and the original glass regenerated. If the anodic layer is heated to a high temperature, a quantity of oxygen is evolved which is equivalent to the amount of Na deposited by the current. At 320° the migration velocity of sodium ions in the glass investigated is approximately 1×10^{-8} cm. per sec./volt. T. S. P.

1796. *Galvanic Ennobling of Metals.* **C. M. van Deventer and H. J. van Lummel.** (Zeitschr. Phys. Chem. 69. pp. 136–147, 1909.)—The normal direction of the current between Zn and Mg in dilute sulphuric acid can be changed by inserting between the Mg and the acid a layer of ethyl or propyl alcohol, which acts as a so-called semi-permeable insulator. Moreover, it can be shown that between one and the same metal a current will flow—that is, self-ennobling takes place—when the one electrode dips into dilute acid (normal sulphuric or hydrochloric acid) and the other into alcohol. In the cell: metal I—acid—alcohol—metal II the current flowed through the connecting wire from II to I, when both metals were the same and consisted respectively of amalgamated Zn, Zn, Cd, amalgamated Sn, Sn, amalgamated Pb, Pb, Ni, Cu, and amalgamated Cu. Ag and Pt gave no current. When the metals I and II were different it was found that Mg could be ennobled with respect to Zn, Cd, Sn, or Ni, Zn with respect to Cd or Sn, and Sn with respect to Pb. T. S. P.

1797. *Migration of the Ions in the Water Voltameter.* **F. Streintz.** (Zeitschr. Elektrochem. 16. pp. 744–747, Sept. 15, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)—The diluted sulphuric acid of a Hofmann voltameter (3 limbs) rises in the kathode limb and sinks in the anode limb. These level-changes are due to the variations in the acid density resulting from the decomposition of water. The author calculates the level-changes which would be counteracted by diffusion and makes experiments with an apparatus consisting of three tubular vessels joined below, the anode and kathode being the outer vessels. The observed level-differences are greater than those calculated, especially in long-continued electrolysis; this may be due to the formation of HSO_4' and of persulphuric acid in addition to the anion SO_4, which the author considers. The observation suggests a new source of error in voltameter determinations which it would be difficult to guard against. H. B.

1798. *Decomposition Potential.* **K. Bennewitz.** (Zeitschr. Phys. Chem. 72. 2. pp. 202–224, 1910. Extract from Inaug.-Dissertation, Berlin, 1909.)—There is always some uncertainty about the decomposition potentials obtained by the method of current-potential curves, since they are partly obtained by graphic interpolation, and consequently one erroneous observation in a series of exact determinations will cause a break in the curve, which break cannot be distinguished from a true decomposition point. This error can be avoided by taking into account not only the observations in the immediate neighbourhood of the decomposition point, but also by analysing all that portion of the curve which lies above the decomposition point. By using rotating electrodes for the deposition of soluble products the form of the current-potential curve is considerably simplified, the diffusion-space being of the same order both before and during the formation of bubbles. This simplification enables one to deduce an equation, based on diffusion, for the current-potential curve above the decomposition point. It is shown, moreover, that the curve giving the relation between the potential and the logarithm of the current can only be used for potentials considerably above the decomposition point; in the neighbourhood of the latter such a curve very easily leads to wrong results. From the equation it also follows that in the electrolysis of dilute sulphuric acid there is a decomposition point at 1·50–1·68 volts against hydrogen; with smooth electrodes this point lies at a higher potential than with rough electrodes. The actual position of the break with platinised electrodes is 1·46 volts, and it is suggested that the decomposition only occurs at this potential at certain points on the electrode, and becomes general at the higher potential deduced from the equation. No breaks, such as have been found by previous investigators, could be detected at 1·47 and 1·95 volts, but with concentrated sulphuric acid containing alkali bisulphate a break occurs at 2·20 volts, corresponding to the reaction $2HSO_4' = H_2S_2O_8 + 2\ominus$. The supposed decomposition point of sulphuric acid at 1·08 volts is due to a discontinuity in the polarisation capacity and is connected with the passivity of Pt. With platinised Pt there is an analogous phenomenon at 0·76 volt, which is shown not only in the polarisation-time curve, but also in the non-stationary current-potential curve. This behaviour can be best explained by the assumption of oxides or hydroxides. The compound between Pt and oxygen causes no passivity at 0·76 volt. T. S. P.

1799. *Anodic Behaviour of Tungsten.* **M. Le Blanc and H. G. Byers.** (Zeitschr. Phys. Chem. 69. pp. 19–25, 1909.)—The tungsten used in the authors' experiments consisted of a 98–99 per cent. "sintered" sample of the metal, and a 100 per cent. "fused" sample. In contra-distinction to Cr, W is inactive towards dilute acids, especially towards hydrochloric acid. At temperatures of from 50–80° C. and with current densities of 7–100 milliamps. per cm.², it dissolves in the hexavalent condition in solutions of phosphoric acid and of disodium hydrogen phosphate. At the current densities mentioned the evolution of oxygen, that is, the passivity, increases with falling temperature, until at 0° C. very little metal, in some cases none at all, goes into solution. Increase in the current density acts in the same way as a fall in the temperature. Fused tungsten shows a greater tendency to remain passive than does the sintered metal. Analogous results were obtained with solutions of oxalic acid and ammonium sulphide. There is no evidence of the formation of a protecting oxide layer which prevents mechanically the anodic attack of the metal. The simplest explanation of the observed phenomena is that they depend on the velocity of reaction between the anode and the electrolyte. [See Abstract No. 654 (1905).] T. S. P.

1800. *Transfer-resistance in the Case of "Reversible" Electrolytic Metal-deposition.* **H. J. S. Sand** and **T. P. Black.** (Zeitschr. Phys. Chem. 70. pp. 496–510, 1910.)—The phenomenon of transfer-resistance during metal-deposition has been investigated with acid solutions of copper sulphate and also with solutions of zinc sulphate and bismuth nitrate. It is found to be a very variable quantity, depending not only on the current strength, but also on the previous treatment of the kathode. In particular, it has been found possible to decrease it very greatly by passing large currents through the electrolyte. There seems to be some indication that definite limits are attained for each current density when large clearing currents are passed through the electrolyte for long periods. Transfer-resistance can be increased very greatly by the addition of colloidal substances. Rise of temperature always decreases transfer-resistance greatly, both in pure solutions and in those to which colloids have been added. The equilibrium potential of the metals copper and zinc has been found to be affected by stirring the electrolyte, the metal becoming more noble during the action of the stirrer. In solutions to which colloids have been added, curious polarisation phenomena have been observed which are probably due to the deposited metal being interwoven with a network of badly conducting colloidal material of extraordinary thinness; it thus behaves as a battery of leaking condensers of extremely high capacity. [See Abstract No. 658 (1905).] T. S. P.

1801. *Thallium as Anode.* I. **W. J. Müller.** (Zeitschr. Phys. Chem. 69. pp. 460–481, 1909.)—The anodic behaviour of thallium was investigated in sodium hydrate solution, dilute sulphuric acid, and sodium sulphate solution, and the results obtained show that Tl can exist in an active or two different passive conditions. In one case the Tl passes into solution as a divalent ion and in the other it behaves as an unattacked electrode. A limiting current strength of the active condition was found, and it was shown that this was identical with the "passive making" current strength observed by other experimenters. The general law of passivity, based upon the electron theory of the passive state, for the passive influence of anions containing oxygen is thus expressed: The passive influence of an anion is inversely proportional to the solubility of the resulting compound in the limiting surface layer. [See also Abstract No. 2805 (1905).] F. J. B.

1802. *Anodic Behaviour of Molybdenum, Manganese, Chromium, and Tantalum.* **H. Kuessner.** (Zeitschr. Elektrochem. 16 pp. 754–772, Sept. 15, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)—The research concerns metals which are known in several valencies, and the author argues on the lines of M. Le Blanc. Molybdenum dissolved hexavalent in 1-N caustic potash and generated oxygen at higher current densities; another specimen of the metal did not yield oxygen, however, when the current intensity was increased, and showed also a more uniform potential curve than the first specimen; analyses are not given. Manganese in neutral electrolytes (KCl, K_2SO_4) generated simultaneously oxygen and hydrogen, and dissolved probably both trivalent and monovalent; when caustic potash was added to the electrolyte, the higher valencies predominated; addition of brucine and strychnine sulphate increased the e.m.f. of polarisation considerably, probably because the chemical reactions were retarded. Chromium dissolved in KCl always in several valencies, on which the current density had no influence; in the heated electrolyte the lower valency predominated; the electrolysis of alcoholic solutions of zinc chloride with Cr anodes did not yield any constant valency. Tantalum became in most electrolytes coated with a layer of an insoluble, badly conducting oxide, which seemed to peel off and to be renewed; a constant current was obtained only in concentrated caustic potash; tantalum dissolved in HF, not in KF. H. B.

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1803. *Constitution of Carbon-Tungsten Steels.* **T. Swinden.** (Iron and Steel Inst., Journ. 80. pp. 223–252; Correspondence, pp. 253–256, 1909. Metallurgie, 6. pp. 720–731, Nov. 22, 1909.)

1804. *Diffusion of Electrolytes in Aqueous Solutions.* **O. Scarpa.** (N. Cimento, 20. pp. 212–226, Sept., 1910.)—The author criticises the results obtained by Buscaglioni and Purgotti, and by Vanzetti [Abstract No. 2145 (1909)]. The theory of the method adopted by the former is deduced mathematically, but the position at which precipitation occurs appears to depend not only on the coefficients of diffusion, but on some factor at present unknown, rendering their results incorrect. Vanzetti's method is shown to be inapplicable to the study of diffusion, and his theory of the hydrolysis by water of the salts examined untenable. W. H. Si.

1805. *Hydration and Molecular Heat of the Ions in very Dilute Aqueous Solutions.* **G. Mie.** (Ann. d. Physik, 33. 2. pp. 381–399, Aug. 30, 1910.)—The hypothesis is put forward that the process of dissociation of a molecule of a salt is a sort of explosion, as a result of which weakly hydrated or non-hydrated ions are formed. For further information the original pages should be referred to. L. H. W.

1806. *Galvanic Polarisation.* **F. Krüger.** (Phys. Zeitschr. 11. pp. 719–730, Aug. 15, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.) —A summarised account of the experimental and theoretical work on the above subject. A. F.

1807. *Potential of the Oxygen Electrode: a Report of Progress.* **E. P. Schoch.** (Journ. Phys. Chem. 14. pp. 665–677, Oct., 1910.)—The paper is a summarised discussion of the work which has been done relating to the potential of the oxygen electrode. A. F.

1808. *Potential Difference between Two Electrolytic Solutions.* **H. Pleijel.** (Zeitschr. Phys. Chem. 72. 1. pp. 1–37, March 22, 1910.)—A mathematical treatment.

1809. *Recent Developments in the Theory of Galvanic Cells.* **W. Nernst.** (Phys. Zeitschr. 11. pp. 716–719, Aug. 15, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)

1810. *The Chemical Reactions of Phosphorescence.* **W. D. Bancroft.** (Zeitschr. Phys. Chem. 68. pp. 15–18, 1909.)